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Toxic Air Contaminant Emissions Inventory and Dispersion Modeling Report for the Commerce Rail Yard, Los Angeles, California

prepared for:

Union Pacific Railroad Company

January 2007

prepared by:

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SUMMARY

In accordance with the 2005 California Air Resources Board (CARB)/Railroad Statewide Agreement (MOU), Union Pacific Railroad Company (UPRR) has prepared a facility-wide emission inventory and dispersion modeling analysis for the Commerce Rail Yard (Yard) in Los Angeles, California. The inventory quantifies emissions of specified toxic air contaminants (TACs) (including Diesel particulate matter [DPM]) from stationary, mobile, and portable sources at the Yard. The inventory has been prepared in accordance with CARB's *Rail Yard Emission Inventory Methodology* guidelines (July 2006) and UPRR's *Emission Inventory Protocol* (May 2006).

The Commerce Yard is a cargo handling facility. Cargo includes intermodal containers and "manifest" cargo (mixed freight). Cargo containers and other freight are received, sorted, and distributed from the facility. Activities at Commerce include receiving inbound trains, switching cars, loading and unloading intermodal trains, storage of intermodal containers and chassis, building and departing outbound trains, and repairing freight cars and intermodal containers/chassis. Facilities within the Yard include classification tracks, a gate complex for inbound and outbound intermodal truck traffic, intermodal loading and unloading tracks, a locomotive service track, a locomotive maintenance shop, a freight car repair shop, an on-site wastewater treatment plant, and various buildings and facilities supporting railroad and contractor operations.

Emission sources include, but are not limited to, locomotives, on-road Diesel-fueled trucks, heavy-heavy-duty Diesel-fueled trucks, cargo handling equipment, transport refrigeration units (TRUs) and refrigerated rail cars (reefer cars), and fuel storage tanks. Emissions were calculated on a source-specific and facility-wide basis for the 2005 baseline year. Emissions from locomotive activities at the adjacent Spence Street Yard are also included in this inventory.

An air dispersion modeling analysis was also conducted for the Commerce Yard. The purpose of the analysis was to estimate ground-level concentrations of DPM and other TACs, emitted from Yard operations, at receptor locations near the Yard. Emission sources included in the modeling analysis were locomotives, heavy-heavy duty (HHD)

Diesel-fueled trucks, Diesel-fueled cargo handling equipment (CHE), Diesel-fueled heavy equipment, and a gasoline storage tank. The air dispersion modeling was conducted using the AERMOD Gaussian plume dispersion model and wind speed and direction data from the Lynwood station operated in the CARB network, and temperature and cloud cover data from the Los Angeles downtown USC station operated by the National Weather Service. The meteorological data were processed using the AERMET program. The modeling analysis was conducted in accordance with the *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006) and UPRR's *Modeling Protocol* (August 2006).

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PART I. INTRODUCTION

In accordance with the 2005 California Air Resources Board (CARB)/Railroad Statewide Agreement (MOU), Union Pacific Railroad Company (UPRR) has prepared a facility-wide emission inventory and dispersion modeling analysis for the Commerce Rail Yard (Yard) in Los Angeles, California. The inventory quantifies emissions of specified toxic air contaminants (TACs) (including Diesel particulate matter [DPM]) from stationary, mobile, and portable sources at the Yard. Emissions from locomotive activities at the adjacent Spence Street Yard are also included in this inventory. The inventory has been prepared in accordance with CARB's *Rail Yard Emission Inventory Methodology* guidelines (July 2006) and UPRR's *Emission Inventory Protocol* (May 2006).

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PART II. FACILITY DESCRIPTION

A. Facility Name and Address

Union Pacific Railroad Company
Commerce Rail Yard
4341 E. Washington Blvd.
Los Angeles, CA 90023

B. Facility Contact Information

Brock Nelson
Director of Environmental Operations – West
Union Pacific Railroad Company
10031 Foothills Boulevard
Roseville, CA 95747
Phone: (916) 789-6370
Fax: (402) 233-3162
banelson@up.com

C. Main Purpose of the Facility

The Commerce Yard is a cargo handling facility. Cargo includes intermodal containers and "manifest" cargo (mixed freight). Cargo containers and other freight are received, sorted, and distributed from the facility. Intermodal containers may arrive at the facility by truck to be loaded onto trains for transport to distant destinations, or arrive by train and unloaded onto chassis for transport by truck to local destinations. Cargo containers and chassis are also temporarily stored at Yard. The Yard also includes facilities for crane and yard hostler maintenance, locomotive service and repair, and an on-site wastewater treatment plant.

D. Types of Operations Performed at the Facility

Activities at Commerce include receiving inbound trains, switching cars, loading and unloading intermodal trains, storage of intermodal containers and chassis, building and departing outbound trains, and repairing freight cars and intermodal containers/chassis. The Yard includes a bypassing main line with freight and passenger train traffic that is not handled in the Yard.

Within the Yard, the primary locomotive activities are associated with arriving and departing intermodal and "manifest" trains (trains handling mixed freight), and servicing the locomotives that power these trains. Arriving and departing trains' locomotives are fueled in the locomotive service area after arrival, and are sent back into the yard or to other yards after service. A locomotive maintenance shop also performs periodic and unscheduled maintenance on locomotives. Two sets of "captive" locomotives (i.e., dedicated to moving sections of rail cars within the yard) also operate within the yard—one set on the west end of the yard, and another set on the east end of the yard. These are used to move sections of inbound trains to appropriate areas within the yard (e.g., intermodal rail cars go to the intermodal ramp for unloading and loading), and to move sections of outbound trains to tracks from which they will depart.

Facilities within the Yard include classification tracks, a gate complex for inbound and outbound intermodal truck traffic, intermodal loading and unloading tracks, a locomotive service track, a locomotive maintenance shop, a freight car repair shop, an on-site wastewater treatment plant, and various buildings and facilities supporting railroad and contractor operations. Emissions from locomotive activities at the adjacent Spence Street Yard are also included in this inventory.

E. Facility Operating Schedule

The facility operates 24 hour per day, 365 days per year.

F. General Land Use Surrounding the Facility

The Commerce Yard covers a triangular area surrounded by both residential and commercial properties, as well as several major freeways. An overpass for the I-710 freeway bisects the Commerce Yard. To the south side of the Yard (just east of the I-710 overpass) there is residential housing. Residences are located within a few feet of the facility fence line, just east of the I-710 overpass. A school is also located in this area. The north side of the Commerce Yard is surrounded by commercial properties and residential housing. Residential properties are located north of the Yard on both sides of the I-710 freeway overpass, approximately 200 feet from the Yard. The location of specific receptors is further discussed in Part IX.

PART III. MAP AND FACILITY PLOT PLAN

Figure 1
Location Map

Figure 2
Commerce Rail Yard Layout

PART IV. COVERED SOURCES

This emission inventory quantifies toxic air contaminant (TAC) emissions from the stationary, mobile, area, and portable sources located or operating at Commerce. Sources include, but are not limited to, locomotives, on-road Diesel-fueled trucks, heavy-heavy-duty Diesel-fueled trucks, cargo handling equipment, heavy equipment, transport refrigeration units (TRUs) and refrigerated railcars (reefer cars), and fuel storage tanks. A site-specific equipment inventory is included in Part V below.

Per the UPRR *Emission Inventory Protocol*, stationary point sources that are exempt from local air district rules have been identified, but not included in the detailed emission inventory. Also, de minimis sources, based on weighted risk, have been identified in the inventory, but have not been further discussed or included in the modeling analysis. De minimis sources are the individual sources that represent less than 3 percent of the facility-total weighted-average site health risk (determined separately for cancer risk and non-cancer chronic health hazard). Total exclusions for all de minimis sources did not exceed 10 percent of the facility-total weighted average site cancer risk or chronic health hazard. De minimis sources are further discussed in Part VIII of this report.

PART V. SITE-SPECIFIC EQUIPMENT INVENTORY

As discussed in Part IV above, there are a number of mobile, stationary, and portable emissions sources operating at Commerce. The mobile sources include locomotives, on-road Diesel-fueled trucks, heavy-heavy duty (HHD) Diesel-fueled trucks, cargo handling equipment (CHE), and other heavy equipment. The stationary emission sources include storage tanks, a sand tower, a wastewater treatment plant, and an emergency generator. Portable equipment operating at the Yard includes transport refrigeration units (TRUs) and refrigerated railcars (reefer cars), welders, air compressors, steam cleaners, an emergency pump, a vacuum, and a jack. Each source group is further discussed below.

A. Locomotives

Locomotive activities at the yard fall into several categories. "Road power" activities (locomotives used on inbound and outbound freight and passenger trains) include hauling through trains on the main line; pulling arriving trains into the yard and departing trains out of the yard; and moving locomotives to and from the service and shop areas after arrival and prior to departure. Yard operations include the use of two sets of medium horsepower locomotives (one set at each end of the yard) to move sections of trains at the ends of the yard. During 2005, the operating set of locomotives on the west end of the yard was a GP-60 coupled to a "slug."[1] At the east end of the yard, the operating set was a pair of SD-40 locomotives. Locomotive servicing and maintenance involves both road power and yard locomotives, and includes idling associated with refueling, sanding, oiling, and waiting to move to outbound trains. In addition, maintenance activities include additional periods of idling and higher throttle settings during load tests either prior to, or following specific maintenance tasks.

[1] A railroad slug is an accessory to a locomotive. A slug is a locomotive unit equipped with an operating cab and traction motors but not a Diesel engine. A slug cannot move under its own power, but instead is connected to a locomotive that provides current to operate the traction motors. Since a slug does not have a Diesel engine, there are no emissions from a slug.

Table 1 lists the number of locomotives in operation (arrivals, departures, and through traffic) at the yard during 2005 by locomotive model group and type of train. Through trains use the main line passing by the facility. Intermodal trains and other trains enter the yard on specified tracks. Power moves are a group of locomotives with no attached railcars, whose objective is either to move locomotives to locations where they are needed, or to take malfunctioning units to service facilities. In general, only one or two locomotives are in operation during power moves.

Table 1
Locomotive Models (Road Power) Identified at
Commerce Rail Yard

Locomotive Model Group	Train Type[1]					
	Through Trains	Intermodal Trains		Other Trains		Power Moves
		Arriving	Departing	Arriving	Departing	
Switch[2]	0	0	0	112	110	23
GP3x	7	1	8	444	442	66
GP4x	2,973	224	397	677	641	730
GP50	122	24	45	15	14	39
GP60	731	197	260	1,483	1,463	663
SD7x	6,405	1,943	2,157	777	730	2,098
SD90	38	9	34	24	7	25
Dash7	7	0	0	4	1	3
Dash8	1,281	360	547	147	117	450
Dash9	3,109	992	1,184	480	379	905
C60A	27	7	13	8	3	11
Unknown	123	25	49	297	290	101
Total	**14,823**	**3,782**	**4,694**	**4,468**	**4,197**	**5,114**

Notes:
1. Includes all locomotives identified on an arriving, a departing, or a through train, including both working and non-working units.
2. Does not include switcher locomotives used for yard operations.

B. <u>On-Road Diesel-Fueled Trucks</u>

A variety of on-road trucks are used, within the Yard, to support Yard activities. Table 2 provides the vehicle specifications for the on-road Diesel-fueled trucks operating at the Yard.

Table 2
Vehicle Specifications for On-Road Diesel-Fueled Trucks
Commerce Rail Yard

Equipment Type	Owner/ID	Make	Model	Model Year
Pickup Truck	ITS-950	Ford	F150	1996
Pickup Truck	ITS-2027	Ford	F250	2000
Pickup Truck	ITS-2018	Ford	F250	2002
Pickup Truck	ITS-2048	Ford	F250	2002
Pickup Truck	UP-19939	Ford	F350	2002
Pickup Truck	ITS-2145	Ford	F350	2002
Pickup Truck	ITS-2141	Ford	F350	2005

Notes:
1. Information provided by UPRR and In-Terminal Services personnel.

C. HHD Diesel-Fueled Trucks

A variety of HHD Diesel-fueled trucks operate at Commerce each day. The HHD trucks are used to pick up and deliver cargo containers. The trucks are owned and operated by many large trucking companies and independent operators (draymen). Therefore, a fleet distribution is not available. For emission calculations, the EMFAC-WD 2006 model default fleet distribution for HHD Diesel-fueled operating in Los Angeles County was used.

D. Cargo Handling Equipment

A variety of heavy equipment is used to load, unload, and move cargo containers in the Yard. Table 3 provides the equipment specifications for cargo handling equipment (CHE) operating at Commerce.

Table 3
Equipment Specifications for Cargo Handling Equipment
Commerce Rail Yard

Equipment Type	Make/Model	Engine Make/Model	Model Year	Rating (hp)	No. of Units
Forklift	Lull	John Deere	1975	150	1
RTG[1]	Mi Jack 1000R	Detroit 671NA	1987	300	2
RTG[1]	Mi Jack 1000R	Detroit 671NA	1991	300	1
RTG[1]	Mi Jack 850R	Detroit DDEC	1996	300	1
RTG[1]	Mi Jack 850R	Detroit DDEC	1997	300	1
RTG[1]	Mi Jack 1000R	Detroit DDEC	2000	300	1
RTG[1]	Taylor 9040	Detroit DDEC	2003	300	2
RTG[1]	Mi Jack 1000RC	Detroit DDEC	2004	300	1
Top Pick	Raygo CH70	Cummins 220	1986	250	1
Chassis Stacker	Taylor TCS90	Cummins 6BT	1993	150	2
Chassis Stacker	Taylor TCS90	Cummins 6BT	1995	150	1
Yard Hostler	Capacity TJ5100	Caterpillar 3116	1999	150	1
Yard Hostler	Capacity TJ5100	Cummins 5.9 BT	1999	150	1
Yard Hostler	Capacity TJ5100	Caterpillar 3116	2000	150	2
Yard Hostler	Capacity TJ5100	Cummins 5.9 BT	2001	150	6
Yard Hostler	Capacity TJ5100	Cummins 5.9 BT	2002	150	3
Yard Hostler	Capacity TJ5100	Cummins 5.9 BT	2003	150	1
Yard Hostler	Capacity TJ5100	Cummins 5.9 BT	2004	150	8
Yard Hostler	Capacity TJ5100	Cummins 5.9 BT	2006	150	3

Notes:
1. Rubber Tire Gantry Crane.

E. <u>Heavy Equipment</u>

In addition to the CHE discussed above, Diesel-fueled heavy equipment is used at Commerce. The heavy equipment is used for non-cargo-related activities at the Yard, such as locomotive maintenance, handling of parts and Company material, derailments, etc. Table 4 provides detailed information for the heavy equipment used at the Yard.

Table 4
Equipment Specifications for Heavy Equipment
Commerce Rail Yard

Equipment Type	Make/Model	Model Year	Rating (hp)	No. of Units
Crane	Lorain RT-450	*2000*	*200*	1
Forklift	Toyota	*1995*	60	3
Forklift	Caterpillar	*1995*	240	1
Forklift	Komatsu	1989	66	1
Trackmobile	Trackmobile TM4000	1990	115	1
Car Movers	NMC	1997	250	2

Notes:
1. Items in italics are engineering estimates.
2. Specifications for the Trackmobile are based on a similar unit at the Stockton Yard.

F. Tanks

There are a number of tanks at the facility that are used to store liquid petroleum products such as Diesel fuel, gasoline, lubricating oils, and recovered oil. Table 5 provides detailed information for all storage tanks located at the facility.

Table 5
Storage Tank Specifications
Commerce Rail Yard

Tank No.	Tank Location	Material Stored	Tank Capacity (gallons)
TNKO-0171[1]	Locomotive Servicing	Lube Oil	20,000
TNKO-9203[1]	Locomotive Servicing	Used Lube Oil	10,000
TNKD-8601	Locomotive Servicing	Diesel	150,000
TNKO-9201[1]	WWTP	Recovered Oil	5,300
TNKO-9202[1]	WWTP	Recovered Oil	5,300
TNKD-1111[1]	WWTP	Diesel	8,000
TNKD-1116[1]	UP Owned	Diesel	1,000
TNKD-0118[1]	Locomotive Servicing	Diesel	1,000
TNKG-0100	Locomotive Servicing	Gasoline	1,000
TNKD-1052	Locomotive Servicing	Diesel	420,000
AST-1[1]	Tractor Maintenance	Used Oil	1,000
AST-2[1]	Tractor Maintenance	Hydraulic Oil	240
AST-3[1]	Tractor Maintenance	Motor Oil	500
AST-4[1]	Crane Maintenance	Motor Oil	350
AST-5[1]	Crane Maintenance	Hydraulic Oil	500
AST-6[1]	Tractor Maintenance	Diesel	500
AST-8[1]	Crane Maintenance	Used Oil	750
AST-9[1]	Northwest Services	Diesel	1,000

Notes:
1. Exempt from permitting requirements per SCAQMD Rule 219(m).

As shown in Table 5, all storage tanks at the facility, except TNKD-8601, TNKG-0100, and TNKD-1052, are exempt from South Coast Air Quality Management District (SCAQMD) permitting requirements per Rule 219(m). Since these storage tanks are exempt from local air district rules, the emissions from these tanks are not included in the inventory or the dispersion modeling analysis, consistent with the UPRR inventory protocol.

G. Sand Tower

Locomotives use sand for traction and braking. The sand tower system consists of a storage system and a transfer system to dispense sand into locomotives. The storage system includes a pneumatic delivery system and a storage silo. The transfer system includes a pneumatic transfer system, an elevated receiving silo, and a moving hopper and gantry system. The system is equipped with a baghouse for emissions control.

H. Wastewater Treatment Plant

The Commerce Yard also has a wastewater treatment plant (WWTP). Equipment at the WWTP includes three basins, an oil/water separator, a dissolved air flotation (DAF) unit, pumps, and storage tanks. Air emission sources at the WWTP are the three basins, an oil/water separator, and the DAF.

I. Emergency Generator

An emergency generator is located at the Yard office building to provide emergency power when electrical service from the local power provider is disrupted. The generator is a 13 horsepower, propane-fueled unit manufactured by Olympian. Internal combustion engines with a rated capacity of 50 brake horsepower or less are exempt from permitting requirements by SCAQMD Rule 219(b)(1). Therefore, the generator is exempt from SCAQMD permitting requirements. Since the emergency generator is exempt from local air district rules, the emissions from the generator are not included in the inventory or the dispersion modeling analysis, consistent with the UPRR inventory protocol.

J. TRUs and Reefer Cars

Transport refrigeration units (TRUs) and refrigerated railcars (reefer cars) are used to transport perishable and frozen goods. TRUs and reefer cars are transferred in and out of the Yard and are temporarily stored at the Yard. The TRUs are owned by a variety of independent shipping companies and equipment-specific data are not available. Therefore, the default equipment rating and distribution contained in the OFFROAD2006 model were used for emission calculations. It was assumed that the number of TRUs and reefer cars in the Yard at any one time remained constant during the year, with individual units cycling in and out of the Yard.

K. Portable Equipment and Steam Cleaners

A variety of portable equipment and steam cleaners are used at the Yard. Equipment specifications for the welders and miscellaneous portable equipment are shown in Table 6.

Table 6
Portable Equipment Specifications
Commerce Rail Yard

Equipment Location	Equipment Type	Number of Units	Fuel Type	Rated Capacity (hp)
WWTP	Welder	1	Gasoline	40
UP Yard	Welder	1	Gasoline	40
Crane Maintenance	Welder	1	Gasoline	20
Car Department	Welder	2	Gasoline	11
Car Department	Welder	2	Gasoline	20
Car Department	Welder	1	Diesel	16
Locomotive Shop	Welder	1	Gasoline	16
Car Department	Air Compressor	1	Diesel	45
Crane Maintenance	Air Compressor	1	Diesel	34
Car Department	Air Compressor	2	Gasoline	5
WWTP	Emergency Pump	1	Gasoline	8
WWTP	Vacuum	1	Gasoline	21
Car Department	Jack	1	Gasoline	11

Internal combustion engines with a rated capacity of 50 brake horsepower or less are exempt from permitting requirements by SCAQMD Rule 219(b)(1). As shown in Table 6, all of the welders and miscellaneous portable equipment operated at Commerce have a rated capacity of less than 50 hp, and therefore are exempt from permitting requirements. Since these units are exempt from local air district rules, the emissions from these units are not included in this inventory or in the dispersion modeling analysis, consistent with the UPRR inventory protocol.

Equipment specifications for the steam cleaners operated at the Commerce Yard are shown in Table 7.

Table 7 Equipment Specifications for Steam Cleaners Commerce Rail Yard				
Equipment Location	Make	Emission Unit	Fuel Type	Rating (MMBtu/hr or hp)
Various[1]	Hydroblaster	Pump	Electric	NA
		Heater	Propane	0.325
Various[1]	Hydroblaster	Pump	Electric	NA
		Heater	Propane	0.325
Various[1]	Hydroblaster	Pump	Electric	NA
		Heater	Propane	0.325
Various[1]	Hydroblaster	Pump	Electric	NA
		Heater	Propane	0.325
Crane Maintenance[2]	Landa	Pump	Gasoline	16
		Heater	Propane	0.350
Trailer Repair Shop[3]	Kohler	Pump	Gasoline	20
		Heater	Decommissioned	NA

Notes:
1. Exempt from permitting requirements per SCAQMD Rule 219(d)(5).
2. The heater in this unit is exempt from SCAQMD permitting requirements per Rule 219(b)(2). The pump is exempt from SCAQMD permitting requirements per Rule 219(b)(1).
3. The pump in this unit is exempt from SCAQMD permitting requirements per Rule 219(b)(1).

SCAQMD Rule 219(d)(5) exempts equipment that is used exclusively for steam cleaning from permitting requirements, provided that the equipment is also exempt per Rule 219(b)(2). Rule 219(b)(2) exempts from permitting requirements boilers and process heaters that have a maximum heat input rate of 2 MMBtu/hr or less and are equipped to be heated exclusively with natural gas, methanol, or liquefied petroleum gas or any combination thereof that does not include an internal combustion engine. As shown in Table 7, the four Hydroblaster steam-cleaning units are exempt from permitting per Rule 219(d)(5). Since these units are exempt from local air district rules, the emissions from these units are not included in this inventory or in the dispersion modeling analysis, consistent with the UPRR inventory protocol.

As discussed above, internal combustion engines with a rated capacity of 50 brake horsepower or less are exempt from permitting requirements by SCAQMD Rule 219(b)(1). As noted in Table 7, the internal combustion engines for the Landa and Kohler steam cleaners have a rated capacity of less than 50 horsepower and are therefore exempt from permitting requirements per Rule 219(b)(1). The heater in the Landa unit qualifies for the permit exemption of Rule 219(b)(2). Since these units are exempt from local air district rules, the emissions from these units are not included in this inventory or in the dispersion modeling analysis, consistent with the UPRR inventory protocol.

PART VI. ACTIVITY DATA

Emissions from mobile sources are based on the number and type of equipment, equipment size, load factor, and operation during the baseline year of 2005. Since fuel consumption data were not available, the default load factors from the OFFROAD2006 model and operating data were used for emission calculations. For sources where operating data weren't available, an average operating mode (AOM) was developed based on employee interviews.

A. Locomotives

Locomotive emissions were based on the number, model distribution, and operating conditions (idling, throttle notch, and speeds of movements, etc). Table 8 summarizes the activity data for locomotives operating on trains at the Commerce Yard, including the number of trains and number of operating locomotives per consist, as well as their idle and operating time, and speed on arrival or departure. In general, arriving trains enter the Yard and stop while the railcars are detached from the locomotive. After the railcars have been detached, the locomotives move to the service area for refueling. On departure, locomotive consists are moved from the service area to the appropriate end of an outbound train. The train departs after completion of the Federal Railroad Administration (FRA) mandated safety inspections (e.g., air pressure and brakes) and the arrival of the train crew. In some cases, trains that are nominally "through" trains (arriving and departing under the same train symbol and date) add or drop cars or locomotives at the Commerce Yard. These trains are counted separately, as the idling period is shorter prior to departure, and the locomotive consist is not disconnected nor moved to the service track.

The Commerce Yard also provides service and maintenance for the road power on trains arriving and departing from the UPRR LATC Yard to the west. Consists from arriving trains at LATC continue to Commerce for refueling and service under a train symbol that designates the arrival at Commerce as a power move. Following service, consists are taken back to LATC by hostlers without using a train symbol. For this reason, the total locomotive count for arriving and departing locomotives on trains shows a net imbalance of approximately 700 locomotives for 2005. This number is consistent with the number of locomotives arriving from LATC on power moves. For purposes of emission calculations, it is assumed that this imbalance represents power moves by hostlers from Commerce to LATC, with the same average consist size as other identified westbound power moves. This results in a net balance in the number of arriving and departing locomotives. Although power moves may have as many as 10 or more locomotives, typically only one or two locomotives are actually operating. For emission calculations, power moves were assumed to have 1.5 operating locomotives (except for power moves involving just one locomotive).[2] In addition to road power, two sets of yard locomotives operate in the yard to move sections of inbound trains, spot them in the appropriate areas for handling, and subsequently reconnect these sections and move them to the appropriate outbound train areas. These two sets of locomotives operate between 7 AM and 11 PM daily.

A separate database provided information on each locomotive handled by the service area and locomotive maintenance shop at Commerce. Locomotive servicing and maintenance involve routine activities to ready a locomotive for operation (refueling, checking oil levels,) as well as a broad range of maintenance activities including both minor repairs (light bulbs, paint, etc.) and major repairs of locomotive components (traction motor replacement, and Diesel engine maintenance requiring load testing). Based on detailed information on the reason and type of service or maintenance performed, separate counts of service and maintenance activities were developed, as detailed in Table 9.

Routine service of locomotives involves idling and short movements in the service area associated with sanding, refueling, oiling, and other service activities prior to their movement to the ready track area where locomotives are consisted for outbound trains. If maintenance is required at the locomotive shop, additional short movements and idling occur. Depending on the type of maintenance, load testing prior to and after maintenance may be performed. The number of these events was determined based on the location

[2] UP personnel report that although the train data records for power moves may show all locomotives "working," in actuality all locomotives except for one at the front and rear end (and more commonly only one at the front end) are shut down as they are not needed to pull a train that consists only of locomotives. Assuming 1.5 working locomotives per power may slightly overestimate the actual average number of working locomotives per power move.

and service codes for each locomotive maintenance event in the database and emissions are calculated based on the number of each type of event

Based on estimates provided by UPRR personnel for the *Roseville Rail Yard Study* (October 2004), routine servicing of a locomotive occurs over several hours, during which time the locomotive may be idling or shut down (if equipped with ZTR/AESS[3] technology). Locomotives must be idling during oil checks. Following service, there is a second two-hour period during which the locomotives may be idling or shut down. For emission calculations, it is assumed that ZTR/AESS-equipped locomotives idle for ½ hour during service and ½ hour after service, and that other units idle for two hours during and two hours after service.

Locomotives that are identified as undergoing maintenance at the locomotive shop (a separate facility from, and about 300 m east of, the service area) are assumed to have two additional one-hour idling periods before and after maintenance, based on estimates provided by UPRR personnel for the *Roseville Rail Yard Study* (CARB, 2004). These idling period emissions are assumed to also account for emissions during the short movements between the two facilities. ZTR/AESS-equipped units are assumed to idle for only ½ hour of each of these periods. Load testing is required by the FRA for periodic quarterly, semiannual, and annual maintenance, and may also be performed as part of unscheduled maintenance. Service and shop databases were used to identify the number of each type of events, as well as the locomotive model, tier, and ZTR/AESS technology distributions. Emission factors were developed for the model distribution for all units in service, and also for the model distribution of the subset of units that underwent load testing. Post-maintenance load testing at Commerce is conducted at the west end of the service building and is assumed to include opacity testing as part of the load testing. The total emissions associated with service and shop activities are the sum

[3] There are two primary types of auto start/stop technology—"Auto Engine Start Stop" (AESS), which is factory-installed on recent model high horsepower units; and the ZTR "SmartStart" system (ZTR), which is a retrofit option for other locomotives. Both are programmed to turn off the Diesel engine after 15 to 30 minutes of idling, provided that various criteria (air pressure, battery charge, and others) are met. The engine automatically restarts if required by one of the monitored parameters. We assume that an AESS/ZTR-equipped locomotive will shut down after 30 minutes of idling in an extended idle event.

of idling during and after service, idling before and after shop maintenance, and load testing. The emissions from shop and service activities are shown in Part VII.

Table 8
Train Activity Summary
Commerce Rail Yard

Train Type	East Bound		West Bound		Arrival/Departing Speed (mph)	Idle Time (hrs)
	No. of Trains	Locomotives per Consist	No. of Trains	Locomotives per Consist		
Through Trains	3,446	2.81	2,190	2.35	30	0.0
Intermodal Train Arrivals	61	1.93	1,205	3.04	5	1.0
Intermodal Train Departures	1,231	3.64	106	2.07	5	2.0
Other Arrivals	12	1.75	49	3.49	5	1.0
Other Departures	26	2.42	3	1.67	5	2.0
Other Arrivals & Departures	565	2.50	1,186	2.41	5	1.0
Power Moves Through	107	2.29	186	1.83	30	0.0
Power Moves Arriving	882	3.31	169	3.74	5	1.0
Power Moves Departing	146	3.93	658	3.33	5	1.0

Notes:

1. Data reflect the number of operating locomotives; locomotives that are being transported, but are not under power, are not shown.
2. In addition to the activities described above, two sets of switcher locomotives are used in Yard operations. These two sets of locomotives operate between 7 AM and 11 PM daily.

Table 9
Locomotive Service and Shop Releases and Load Tests
Commerce Rail Yard

Activity	Number of Events	Idling per event (min)[4]	N1 time (min)	N8 time (min)
Locomotive Service	9,467	240 (60)	0	0
Shop Maintenance	4,101	120 (60)	0	0
Planned Maintenance Pre-Test	427	2	0	8
Planned Maintenance Post-Test	427	10	10	10
Quarterly Maintenance Test	402	2	0	8
Unscheduled Maintenance Diagnostic	35	5	0	10
Unscheduled Maintenance Post-Test	1,061	10	10	10

B. On-Road Diesel-Fueled Trucks

Emissions from the on-road Diesel-fueled trucks operating at the Yard are based on the engine model year, annual vehicle miles traveled (VMT), and the amount of time spent idling. Table 10 summarizes the activity data for the on-road Diesel-fueled trucks operating at the Yard.

4 Service events assume a total idling duration before and during service of two hours for non-AESS/ZTR units (one-half hour for AESS/ZTR units). Post-service idling durations of two hours (or one half hour for AESS/ZTR units) are also assumed. Pre- and post-maintenance events at the shop are each assumed to include a total idling duration of one hour (one half hour for AESS/ZTR units)

Table 10
Activity Data for On-Road Diesel-Fueled Trucks
Commerce Rail Yard

Vehicle Type	Owner/ID	Make/Model	Model Year	Annual VMT[1]	Idling Time[2] (min/day)	Idling Time[2] (hr/yr)
Pickup Truck	ITS-950	Ford F150	1996	14,000	15	91
Pickup Truck	ITS-2027	Ford F250	2000	15,000	15	91
Pickup Truck	ITS-2018	Ford F250	2002	22,000	15	91
Pickup Truck	ITS-2048	Ford F250	2002	24,000	15	91
Pickup Truck	UP-19939	Ford F350	2002	43,000	15	91
Pickup Truck	ITS-2045	Ford F350	2002	22,000	15	91
Pickup Truck	ITS-2141	Ford F350	2005	38,000	15	91

Notes:
1. Annual VMT and idling time provided by ITS and UPRR personnel and are based on the current odometer reading and the age of the vehicle.
2. Idling time (min/day) is an engineering estimate based on personal observation.

C. HHD Diesel-Fueled Trucks

Emissions from HHD Diesel-fueled trucks are based on the number of truck trips, the length of each trip, and the amount of time spent idling. Gate count data were used to determine the number of HHD trucks operating at Commerce during the 2005 calendar year. UPRR personnel count the number of cargo containers processed through both the “in” and “out” gates of the Yard. Since each HHD truck holds only one cargo container, the gate counts were used to determine the number of HHD truck trips for 2005. Trucks that enter or exit the facility without a chassis and/or a cargo container are referred to as “bobtails.” Based on personal communication with the Intermodal Operations Manager at Commerce, the monthly gate counts were increased by 25% to account for bobtails. The monthly gate count data for 2005, including the estimated number of bobtails, are summarized in Table 11.

Table 11
Summary of Gate Count Data
Commerce Rail Yard

Month	In-Gate Total[1]	Out-Gate Total[1]	Bobtails[2]	Total
January	8,633	8,326	4,240	21,199
February	13,105	8,554	5,415	27,074
March	15,190	13,006	7,049	35,245
April	15,523	11,808	6,833	34,164
May	16,027	12,247	7,069	35,343
June	17,207	13,271	7,620	38,098
July	15,862	11,552	6,854	34,268
August	13,871	10,814	6,171	30,856
September	15,132	7,364	5,624	28,120
October	16,195	8,914	6,277	31,386
November	15,626	9,609	6,309	31,544
December	12,561	9,151	5,428	27,140
Totals	**174,932**	**124,616**	**74,887**	**374,435**

Notes:
1. Provided by UPRR.
2. Bobtails are trucks without a chassis and/or container. Based on personal communication with the Intermodal Operations Manager, it was assumed bobtail counts are equal to 25% of the container count.

Table 12 summarizes the remaining activity data, such as annual VMT and idling time, for HHD Diesel-fueled trucks. In addition to the traveling emissions, an average idling time of 30 minutes per HHD truck trip was assumed to account for emissions during truck queuing, staging, loading and/or unloading. Based on discussions with the Intermodal Operations Manager, the average queuing time at the gate at Commerce is less than 10 minutes per truck. In addition to idling during queuing, it was assumed that each truck idles an average of 15 minutes per trip while the chassis is connected/disconnected from the truck cab. An additional 5 minutes of idle per trip was included to account for any other delays.

Table 12
Summary of HHD Diesel Truck Activity Data
Commerce Rail Yard

Number of HHD Truck Trips[1]	VMT per HHD Truck Trip (mi/trip)[2]	Annual VMT (mi/yr)	Idling Time	
			(min/trip)[2]	(hr/yr)
374,435	1.5	561,652.5	30	187,217.5

Notes:
1. Provided by UPRR. See Table 11.
2. Engineering estimate based on personal communication with the Intermodal Operations Manager for the Commerce Yard.

D. Cargo Handling Equipment

Emissions from CHE operating at the Yard are based on the number and type of equipment, equipment model year, equipment size, and the annual hours of operation. Activity data for CHE are summarized in Table 13.

Table 13
Activity Data for Cargo Handling Equipment
Commerce Rail Yard

Equipment Type	Make/Model	Model Year	Rating (hp)	No. of Units	Hours of Operation (hr/yr per unit)
Forklift	Lull	1975	150	1	*365*
RTG	Mi Jack 1000R	1987	300	2	2,448
RTG	Mi Jack 1000R	1991	300	1	2,448
RTG	Mi Jack 850R	1996	300	1	2,448
RTG	Mi Jack 850R	1997	300	1	2,448
RTG	Mi Jack 1000R	2000	300	1	2,448
RTG	Taylor 9040	2003	300	2	2,448
RTG	Mi Jack 1000RC	2004	300	1	2,448
Top Pick	Raygo CH70	1986	250	1	60
Chassis Stacker	Taylor TCS90	1993	150	2	1,152
Chassis Stacker	Taylor TCS90	1995	150	1	1,152
Yard Hostler	Capacity TJ5100	1999	150	2	4,680
Yard Hostler	Capacity TJ5100	1999	150	1	4,680
Yard Hostler	Capacity TJ5100	2000	150	2	4,680
Yard Hostler	Capacity TJ5100	2001	150	6	4,680
Yard Hostler	Capacity TJ5100	2002	150	3	4,680
Yard Hostler	Capacity TJ5100	2003	150	1	4,680
Yard Hostler	Capacity TJ5100	2004	150	8	4,680
Yard Hostler	Capacity TJ5100	2006	150	3	4,680

Notes:
1. Items in italics are engineering estimates based on operator interviews.

E. Heavy Equipment

Emissions from heavy equipment operating at the Yard are based on the number and type of equipment, equipment model year, equipment size, and the annual hours of operation. Activity data for heavy equipment are summarized in Table 14.

Table 14 Activity Data for Heavy Equipment Commerce Rail Yard					
Equipment Type	Make/Model	Model Year	Rating (hp)	No. of Units	Hours of Operation (hr/yr per unit)
Crane	Lorain RT-450	*2000*	*200*	1	150
Forklift	Toyota	*1995*	60	3	*365*
Forklift	Caterpillar	*1995*	240	1	*365*
Forklift	Komatsu	1989	66	1	*365*
Trackmobile	Trackmobile TM4000	1990	115	1	*730*
Car Movers	NMC	1997	250	2	156

Notes:
1. Items in italics are engineering estimates based on operator interviews.

F. Tanks

Emissions from the non-exempt storage tanks located at the Commerce Yard are based on the size of the tank, material stored, and annual throughput. Activity data for the non-exempt tanks are shown in Table 15.

Table 15 Activity Data for Storage Tanks Commerce Rail Yard					
Tank No.	Tank Location	Material Stored	Tank Capacity (gal)	Tank Dimensions (ft)	Annual Throughput (gal/yr)[1]
TNKD-8601	Locomotive Servicing	Diesel	150,000	20 x 36	5,018,911
TNKG-0100	Locomotive Servicing	Gasoline	1,000	11 x 3 x 4	10,000
TNKD-1052	Locomotive Servicing	Diesel	420,000	32 x 47.5	15,056,734

Notes:
1. Information provided by UPRR personnel.

G. Sand Tower

Emissions from the sand tower are based on the annual sand throughput. The 2005 sand throughput for the Commerce Yard was 5,258 tons.

H. Wastewater Treatment Plant

Emissions from the WWTP are based on the annual wastewater flow rate. In 2005, the wastewater flow rate at Commerce was 2,105,044 gallons.

I. TRUs and Reefer Cars

Emissions from TRUs and reefer cars are based on average size of the units, the average number of units in the Yard, and the hours of operation for each unit. Activity data for TRUs and reefer cars are summarized in Table 16.

Table 16
Activity Data for TRUs and Reefer Cars
Commerce Rail Yard

Equipment Type	Average Rating (hp)[1]	Average No. of Units in Yard[2]	Hours of Operation	
			(hr/day)[3]	(hr/yr)[4]
Container	28.56	10	4	1,460
Railcar	34	4	4	1,460

Notes:
1. Based on the average horsepower distribution in the OFFROAD2006 model.
2. UPRR staff estimates and car data reports indicate that there are 3-5 TRUs and 0-2 reefer cars in the Yard at any given time. To be conservative, these estimates were increased by 100%.
3. From CARB's *Staff Report: Initial Statement of Reason for Proposed Rulemaking for Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets, and Facilities Where TRUs Operate*, October 2003.
4. It was assumed that the number of units and the annual hours of operation remain constant, with individual units cycling in and out of the Yard.

PART VII. EMISSIONS

A. Calculation Methodology and Emission Factors

Emission calculations were based on the site-specific equipment inventory, equipment activity data, and the source-specific emission factors. The calculation methodology and emission factors for each specific source type are further discussed below. Emissions were calculated in accordance with CARB Guidelines (July 2006) and the UPRR *Emission Inventory Protocol* (May 2006).

1. Locomotives

Emissions were calculated for UPRR-owned and -operated locomotives, as well as "foreign" locomotives[5] operating in the rail yard, and through trains on the main line. Procedures for calculating emissions followed the methods described in Ireson et al. (2005).[6] A copy of Ireson et al is contained in Appendix A-6.

Emissions from locomotive activities were calculated based on the number of working locomotives, time spent in each notch setting, and locomotive model-group distributions, with model groups defined by manufacturer and engine type.[7] A separate calculation was performed for each type of locomotive activity, including line-haul or switcher locomotive operations, consist movements, locomotive refueling, and pre- and-post locomotive service and maintenance testing. Speed, movement duration, and throttle notch values were obtained from UPRR personnel for the Commerce yard for different types of activities. Detailed counts of locomotive by model, tier, and train type are shown in Appendix A-1 and A-2. Maps detailing the principle locomotive routes at the Yard are contained in Appendix A-5.

[5] Foreign locomotives are locomotives not owned by UPRR, including passenger trains and locomotives owned by other railroads that are brought onto the UPRR system via interchange.

[6] Ireson, R.G., M.J. Germer, L.A. Schmid (2005). "Development of Detailed Rail yard Emissions to Capture Activity, Technology, and Operational Changes." Proceedings of the USEPA 14th Annual Emission Inventory Conference, *http://www.epa.gov/ttn/chief/conference/ei14/session8/ireson.pdf*, Las Vegas NV, April 14, 2006.

[7] Emission estimates are based on the total number of working locomotives. Therefore, the total number of locomotives used in the emission calculations, shown in Table 8, is slightly lower than the total number of locomotives counted as arriving, departing, or through trains (shown in Table 1). See Appendix A for detailed emission calculations.

Notch-specific emission factors were assembled from a number of sources. These included emission factors presented in CARB's *Roseville Rail Yard Study* (October, 2004), as well as EPA certification data and other testing by Southwest Research Institute of newer-technology locomotives.

For line haul operations, yard-specific average consist composition (number of units, number of units operating, model distribution, locomotive tier distribution, fraction equipped with auto start/stop technology) was developed from UPRR data for different train types. Movement speed, duration, and notch estimates were developed for arriving, departing, through train, and in-yard movements. Idle duration was estimated based on UPRR operator estimates for units not equipped with auto start/stop. Units that were equipped with AESS/ZTR technology were assumed to idle for 30 minutes per extended idle event, with other locomotives idling for the remaining duration of the event. Numbers of arrivals and departures were developed from UPRR data. Emissions were calculated separately for through trains, intermodal train arrivals and departures, non-intermodal arrivals and departures, local trains, and power moves.

Two sets of "captive" locomotives (i.e., dedicated to moving sections of rail cars within the yard) operated within the facility boundaries. These units were a GP-60 connected to a "slug" (see footnote 1) and two SD040s, with each set operating from 7 AM to 11 PM daily. Based on information from UPRR personnel, these units were assumed to operate on the full EPA switcher duty cycle.

Data regarding the sulfur content of 2005 UPRR Diesel fuel deliveries within and outside of California were not available. To develop locomotive emission factors for different types of activities, estimates of fuel sulfur content were developed, and base case emission factors from the primary information sources (e.g., EPA certification data, with an assumed nominal fuel sulfur content of 3,000 ppm) were adjusted based on the estimated sulfur content of in-use fuels. Fuel sulfur content reportedly affects the emission rates for Diesel particulate matter from locomotives. The sulfur content in Diesel fuel varies with the type of fuel produced (e.g., California on-road fuel, 49-state off-road fuel, 49-state on-road fuel), the refinery configuration at which it is produced, the sulfur content of the crude oil being refined, and the extent to which it may be mixed with fuel from other sources during transport. As a result, it is extremely difficult to determine with precision the sulfur content of the fuel being used by any given locomotive at a specific time, and assumptions were made to estimate sulfur content for different types of activities.

To estimate the fuel sulfur content for UPRR locomotives in California during 2005, the following assumptions were made:

- “Captive” locomotives and consists in use on local trains (e.g., commuter rail) used only Diesel fuel produced in California.
- Trains arriving and terminating at California railyards (with the exception of local trains) used fuel produced outside of California, and arrive with remaining fuel in their tanks at 10 percent of capacity.
- On arrival, consists were refueled with California Diesel fuel, resulting in a 90:10 mixture of California and non-California fuel, and this mixture is representative of fuel on departing trains as well as trains undergoing load testing (if conducted at a specific yard).
- The average composition of fuel used in through trains by-passing a yard, and in trains both arriving and departing from a yard on the same day is 50 percent California fuel and 50 percent non-California fuel.

In 2005, Chevron was Union Pacific Railroad’s principal supplier of Diesel fuel. Chevron’s California refineries produced only one grade (“low sulfur Diesel” or LSD) in 2005. Quarterly average sulfur content for these refineries ranged from 59 ppm to 400 ppm, with an average of 221 ppm[8]. This value is assumed to be representative of California fuel used by UPRR. Non-California Diesel fuel for 2005 is assumed to have a sulfur content of 2,639 ppm. This is the estimated 49-state average fuel sulfur content used by the U.S. Environmental Protection Agency in its 2004 regulatory impact analysis in support of regulation of nonroad Diesel engines (EPA, 2004).

[8] Personal communication from Theron Hinckley of Chevron Products Company to Jon Germer of UPRR and Rob Ireson, December 13, 2006.

To develop emission inventories for locomotive activity, an initial collection of locomotive model- and notch-specific emissions data was adjusted based on sulfur content. Although there is no official guidance available for calculating this effect, a draft CARB document provides equations to calculate the effect of sulfur content on DPM emission rates at specific throttle settings, and for 2-stroke and 4-stroke engines (Wong, undated). These equations can be used to calculate adjustment factors for different fuels as described in Appendix A-7. The adjustment factors are linear in sulfur content, allowing emission rates for a specific mixture of California and non-California fuels to be calculated as a weighted average of the emission rates for each of the fuels. Adjustment factors were developed and used to prepare tables of emission factors for two different fuel sulfur levels: 221 ppm for locomotives operated on California fuel; and 2,639 ppm for locomotives operating on non-California fuel. These results are shown in Tables 17 and 18. Sample emission calculations are shown in Appendix A-3 and A-4. The calculations of sulfur adjustments and the Wong Technical Memo are shown in Appendix A-7.

2. <u>On-Road Diesel-Fueled Trucks</u>

Emission estimates for the on-road Diesel-fueled trucks are based on the vehicle class, vehicle model year, annual VMT within the Yard, and amount of time the vehicles spend idling. Vehicle-specific emission factors, calculated using the EMFAC-WD 2006 model, are shown in Table 19. Per CARB guidelines, the emissions from idling and traveling modes have been separated because different source treatments (point or volume sources) will be used in the air dispersion modeling analysis for these modes. Detailed emission factor derivation calculations and EMFAC-WD 2006 output are contained in Appendix B.

Table 17
Locomotive Diesel Particulate Matter Emission Factors (g/hr)
Adjusted for Fuel Sulfur Content of 221 PPM
Commerce Rail Yard

Model Group	Tier	Throttle Setting										Source[1]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	129.2	140.6	173.3	272.7	315.6	409.1	ARB and ENVIRON
GP-3x	N	38.0	72.0	31.0	110.0	174.1	187.5	230.2	369.1	423.5	555.1	ARB and ENVIRON
GP-4x	N	47.9	80.0	35.7	134.3	211.9	228.6	289.7	488.5	584.2	749.9	ARB and ENVIRON
GP-50	N	26.0	64.1	51.3	142.5	282.3	275.2	339.6	587.7	663.5	847.2	ARB and ENVIRON
GP-60	N	48.6	98.5	48.7	131.7	266.3	264.8	323.5	571.6	680.2	859.8	ARB and ENVIRON
GP-60	0	21.1	25.4	37.6	75.5	224.1	311.5	446.4	641.6	1029.9	1205.1	KCS7332
SD-7x	N	24.0	4.8	41.0	65.7	146.8	215.0	276.8	331.8	434.7	538.0	ARB and ENVIRON
SD-7x	0	14.8	15.1	36.8	61.1	215.7	335.9	388.6	766.8	932.1	1009.6	ARB and ENVIRON
SD-7x	1	29.2	31.8	37.1	66.2	205.3	261.7	376.5	631.4	716.4	774.0	NS2630[3]
SD-7x	2	55.4	59.5	38.3	134.2	254.4	265.7	289.0	488.2	614.7	643.0	UP8353[3]
SD-90	0	61.1	108.5	50.1	99.1	239.5	374.7	484.1	291.5	236.1	852.4	EMD 16V265H
Dash 7	N	65.0	180.5	108.2	121.2	306.9	292.4	297.5	255.3	249.0	307.7	ARB and ENVIRON
Dash 8	0	37.0	147.5	86.0	133.1	248.7	261.6	294.1	318.5	347.1	450.7	ARB and ENVIRON
Dash 9	N	32.1	53.9	54.2	108.1	187.7	258.0	332.5	373.2	359.5	517.0	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	195.7	235.4	552.7	489.3	449.6	415.1	Average of CARB & CN2508[1]
Dash 9	1	16.9	88.4	62.1	140.2	259.5	342.2	380.4	443.5	402.7	570.0	CSXT595[2]
Dash 9	2	7.7	42.0	69.3	145.8	259.8	325.7	363.6	356.7	379.7	445.1	BNSF 7736[2]
C60-A	0	71.0	83.9	68.6	78.6	237.2	208.9	247.7	265.5	168.6	265.7	ARB and ENVIRON

Notes:
1. Except as noted below, the base emission rates were originally developed for the CARB *Roseville Rail Yard Study* (October 2004)
2. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
3. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).

Table 18
Locomotive Diesel Particulate Matter Emission Factors (g/hr)
Adjusted for Fuel Sulfur Content of 2,639 PPM
Commerce Rail Yard

Model Group	Tier	Throttle Setting										Source[1]
		Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	
Switchers	N	31.0	56.0	23.0	76.0	136.9	156.6	197.4	303.4	341.2	442.9	ARB and ENVIRON
GP-3x	N	38.0	72.0	31.0	110.0	184.5	208.8	262.2	410.8	457.9	601.1	ARB and ENVIRON
GP-4x	N	47.9	80.0	35.7	134.3	224.5	254.6	330.0	543.7	631.6	812.1	ARB and ENVIRON
GP-50	N	26.0	64.1	51.3	142.5	299.0	306.5	386.9	653.9	717.3	917.4	ARB and ENVIRON
GP-60	N	48.6	98.5	48.7	131.7	282.1	294.9	368.5	636.1	735.4	931.0	ARB and ENVIRON
GP-60	0	21.1	25.4	37.6	75.5	237.4	346.9	508.5	714.0	1113.4	1304.9	KCS7332
SD-7x	N	24.0	4.8	41.0	65.7	155.5	239.4	315.4	369.2	469.9	582.6	ARB and ENVIRON
SD-7x	0	14.8	15.1	36.8	61.1	228.5	374.1	442.7	853.3	1007.8	1093.2	ARB and ENVIRON
SD-7x	1	29.2	31.8	37.1	66.2	217.5	291.5	428.9	702.6	774.5	838.1	NS2630[3]
SD-7x	2	55.4	59.5	38.3	134.2	269.4	295.9	329.2	543.3	664.6	696.2	UP8353[3]
SD-90	0	61.1	108.5	50.1	99.1	253.7	417.3	551.5	324.4	255.3	923.1	EMD 16V265H
Dash 7	N	65.0	180.5	108.2	121.2	352.7	323.1	327.1	293.7	325.3	405.4	ARB and ENVIRON
Dash 8	0	37.0	147.5	86.0	133.1	285.9	289.1	323.3	366.4	453.5	593.8	ARB and ENVIRON
Dash 9	N	32.1	53.9	54.2	108.1	215.7	285.1	365.6	429.3	469.7	681.2	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	224.9	260.1	607.7	562.9	587.4	546.9	Average of CARB & CN2508[1]
Dash 9	1	16.9	88.4	62.1	140.2	298.2	378.1	418.3	510.2	526.2	751.1	CSXT595[2]
Dash 9	2	7.7	42.0	69.3	145.8	298.5	359.9	399.8	410.4	496.1	586.4	BNSF 7736[2]
C60-A	0	71.0	83.9	68.6	78.6	272.6	230.8	272.3	305.4	220.3	350.1	ARB and ENVIRON

Notes:
1. Except as noted below, the base emission rates were originally developed for the CARB *Roseville Rail Yard Study* (October 2004)
2. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
3. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).

Table 19
Emission Factors for On-Road Diesel-Fueled Trucks
Commerce Rail Yard

Owner/ID	Make/Model	Model Year	Vehicle Class	Traveling Emission Factors (g/mi)[1]					Idling Emissions Factors (g/hr)[1,2]				
				ROG	CO	NOx	DPM	SOx	ROG	CO	NOx	DPM	SOx
ITS-950	Ford F150	1996	LDT	0.11	1.11	1.62	0.07	0.04	0.000	0.000	0.000	0.000	0.000
ITS-2027	Ford F250	2000	MDV	0.13	1.13	0.48	0.13	0.00	0.000	0.000	0.000	0.000	0.000
ITS-2018	Ford F250	2002	MDV	0.10	1.16	1.64	0.10	0.00	0.000	0.000	0.000	0.000	0.000
ITS-2048	Ford F250	2002	MDV	0.10	1.16	1.64	0.10	0.00	0.000	0.000	0.000	0.000	0.000
UP-19939	Ford F350	2002	LHDT1	0.35	1.76	6.73	0.09	0.05	3.17	26.30	75.05	0.75	0.34
ITS-2145	Ford F350	2002	LHDT1	0.35	1.76	6.73	0.09	0.05	3.17	26.30	75.05	0.75	0.34
ITS-2141	Ford F350	2005	LHDT1	0.22	1.45	5.73	0.06	0.06	3.17	26.30	75.05	0.75	0.34

Notes:
1. Emission factors calculated using the EMFAC-WD 2006 model with the BURDEN output options
2. Idling Emission factors for LHDT1 vehicles calculated using the EMFAC-WD 2006 model with the EMFAC output option.
3. See Table 3 for vehicle specifications.
4. Diesel PM_{10} (DPM) is a TAC.

3. HHD Diesel-Fueled Trucks

Emission estimates for the HHD Diesel-fueled trucks are based on the number of truck trips, the annual VMT within the Yard, and the amount of idling time. Per CARB guidelines, the emissions from idling and traveling modes have been separated because different source treatments (point or volume sources) will be used in the air dispersion modeling analysis for these modes. A fleet average emission factor for traveling exhaust emissions was calculated using the EMFAC-WD 2006 model with the BURDEN output option. Since the fleet distribution is not known, the EMFAC-WD 2006 default distribution for Los Angeles County was used. Idling emission factors were calculated using the EMFAC-WD 2006 model with the EMFAC output option. The emission factors for the HHD Diesel-fueled trucks are shown in Table 20. Detailed emission factor derivation calculations and the EMFAC-WD 2006 output are contained in Appendix C.

Table 20
Emission Factors for HHD Diesel-Fueled Trucks
Commerce Rail Yard

Operating Mode	Fleet Average Emission Factors				
	ROG	CO	NOx	DPM	SOx
Traveling (g/mi)[1]	5.73	15.40	27.41	2.27	0.24
Idling (g/hr)[2]	16.16	52.99	100.38	2.85	0.55

Notes:
1. Emission factors calculated using the EMFAC-WD 2006 model with the BURDEN output option. The default fleet distribution for Los Angeles County was used.
2. Emission factors calculated using the EMFAC-WD 2006 model with the EMFAC output option. The default fleet distribution for Los Angeles County was used.
3. See Part V for vehicle specifications.
4. Diesel PM_{10} (DPM) is a TAC.

4. Cargo Handling Equipment

Emission estimates for the CHE are based on the number and type of equipment, the equipment model, and the hours of operation. Emission factors were calculated by CARB staff and are based on the OFFROAD2006 model. The emission factors for the CHE are shown in Table 21. Detailed emission factor derivation calculations and OFFROAD2006 output are contained in Appendix D.

Table 21
Emission Factors for Cargo Handling Equipment
Commerce Rail Yard

Equipment Type	Make/Model	Model Year	Emission Factors (g/hp-hr)[1] VOC	CO	NOx	DPM	SOx
Forklift	Lull	1975	1.032	5.491	13.582	0.694	0.060
RTG	Mi Jack 1000R	1987	0.886	5.182	12.498	0.679	0.052
RTG	Mi Jack 1000R	1991	0.669	3.263	8.928	0.444	0.052
RTG	Mi Jack 850R	1996	0.287	1.048	6.616	0.169	0.052
RTG	Mi Jack 850R	1997	0.281	1.035	6.547	0.165	0.052
RTG	Mi Jack 1000R	2000	0.264	0.997	6.340	0.151	0.052
RTG	Taylor 9040	2003	0.093	0.958	4.209	0.101	0.052
RTG	Mi Jack 1000RC	2004	0.091	0.946	4.162	0.097	0.052
Top Pick	Raygo CH70	1986	0.943	5.367	12.617	0.720	0.060
Chassis Stacker	Taylor TCS90	1993	0.579	2.981	8.290	0.367	0.060
Chassis Stacker	Taylor TCS90	1995	0.565	2.938	8.183	0.354	0.060
Yard Hostler	Capacity TJ5100	1999	0.550	2.889	6.942	0.372	0.060
Yard Hostler	Capacity TJ5100	1999	0.550	2.889	6.942	0.372	0.060
Yard Hostler	Capacity TJ5100	2000	0.541	2.862	6.885	0.364	0.060
Yard Hostler	Capacity TJ5100	2001	0.532	2.835	6.827	0.355	0.060
Yard Hostler	Capacity TJ5100	2002	0.524	2.808	6.770	0.347	0.060
Yard Hostler	Capacity TJ5100	2003	0.250	2.781	5.117	0.214	0.060
Yard Hostler	Capacity TJ5100	2004	0.164	2.754	4.553	0.165	0.060
Yard Hostler	Capacity TJ5100	2006	0.115	2.700	4.209	0.132	0.060

Notes:
1. Emission factors calculated by CARB staff and are based on the OFFROAD2006 model.

5. Heavy Equipment

Emission estimates for the heavy equipment are based on the number and type of equipment, the equipment model, and the hours of operation. Emission factors were calculated using OFFROAD2006 model. The emission factors for heavy equipment are shown in Table 22. Detailed emission factor derivation calculations and OFFROAD2006 output are contained in Appendix E.

Table 22
Emission Factors for Heavy Equipment
Commerce Rail Yard

Equipment Type	Make/Model	Model Year	Emission Factors (g/hp-hr)[1]				
			VOC[2]	CO	NOx	DPM	SOx
Crane	Lorain RT-450	*2000*	0.51	1.09	6.87	0.17	0.05
Forklift	Toyota	*1995*	2.23	5.23	11.69	1.23	0.06
Forklift	Caterpillar	*1995*	1.91	5.29	14.41	0.81	0.08
Forklift	Komatsu	1989	0.28	6.23	13.72	1.64	0.06
Trackmobile	Trackmobile TM4000	1990	2.41	5.53	12.29	1.35	0.06
Car Movers	NMC	1997	0.51	1.10	6.92	0.17	0.05

Notes:
1. Emission factors from the OFFROAD2006 model.
2. Evaporative emissions for these sources are negligible.

6. Tanks

VOC emissions from the storage tanks were calculated using EPA's TANKS program. CARB's speciation database was used to determine the fraction of each TAC in the total VOC emissions from gasoline storage tank TNKG-0100. All TACs listed in the most recent version of the Emission Inventory Criteria and Guidelines Report for the Air Toxics "Hot Spots" Program have been included. The TAC emission factors for gasoline storage are shown in Table 23. The TANKS output and the relevant sections of CARB's speciation database are included in Appendix F.

CARB's speciation database does not include information on TAC fractions from Diesel storage tanks. Therefore, TACs from TNKD-8601 and TNKD-1052 will not be included in this report.

Table 23
TAC Emission Factors for Gasoline Storage Tank
Commerce Rail Yard

CAS	Chemical Name	Organic Fraction of VOC (by weight)
540841	2,2,4-trimethylpentane	0.0129
71432	Benzene	0.0036
110827	Cyclohexane	0.0103
100414	Ethylbenzene	0.0012
78784	Isopentane	0.3734
98828	Isopropylbenzene (cumene)	0.0001
108383	m-Xylene	0.0034
110543	n-Hexane	0.0154
95476	o-Xylene	0.0013
106423	p-Xylene	0.0011
108883	Toluene	0.0170
Total		**0.44**

Notes:
1. The organic fraction information is from CARB's speciation database. Data are from the "Headspace vapors 1996 SSD etoh 2.0% (MTBE phaseout)" option.
2. Emissions were calculated only for chemicals that were in both CARB's speciation database and the AB2588 list.

7. Sand Tower

Emission estimates for the sand tower are based on annual sand throughput and emission factors from EPA's AP-42 document. The sand transfer system consists of two parts: pneumatic transfer and gravity transfer. The pneumatic transfer system is similar to those used to unload cement at concrete batch plants. The gravity feed system is similar to the sand and aggregate transfer operations at concrete batch plants. Therefore, emissions will be calculated using the AP-42 emission factors for concrete batch plants. As previously discussed, the system is equipped with a baghouse; therefore, emission factors for a controlled system were used. These emission factors are shown in Table 24.

Table 24
Emission Factors for Sand Tower Operations
Commerce Rail Yard

Pollutant	Emission Factors (lb/ton)	
	Pneumatic Transfer[1]	Gravity Transfer[2]
PM_{10}	0.00034	0.00099

Notes:
1. Emission factor from AP-42, Table 11.12-5, 6/06. Factor for controlled pneumatic cement unloading to elevated storage silo was used. The unit is equipped with a fabric filter.
2. Emission factor from AP-42, Table 11.12-5, 6/06. Factor for sand transfer was used.
3. There are no TAC emissions from this source.

8. Wastewater Treatment Plant

Emission estimates for the WWTP are based on emission rates from the *Air Emission Inventory and Regulatory Analysis Report for Commerce Yard* (Trinity Consultants, August 12, 2004) and the annual wastewater flow rate. Emission rates were calculated by Trinity Consultants using EPA's WATER9 program. The emission rates are shown in Table 25.

Table 25
Emission Factors for the Wastewater Treatment Plant
Commerce Rail Yard

Pollutant	Emission Rate (grams/sec)
Benzene	5.13×10^{-7}
Bis (2-ethylhexyl) Phthalate	2.53×10^{-8}
Bromomethane	9.00×10^{-7}
Chloroform	6.30×10^{-7}
Ethylbenzene	3.06×10^{-6}
Methylene Chloride	1.08×10^{-5}
Toluene	3.51×10^{-6}
Xylene	6.30×10^{-6}
Total	$\mathbf{2.57 \times 10^{-5}}$

Notes:
1. Emission rates from *Air Emission Inventory and Regulatory Analysis for Commerce Yard*, Trinity Consultants, August 12, 2004.

9. TRUs and Reefer Cars

Emission estimates for the Diesel-fueled TRUs and reefer cars were based on the average number of units in the yard and the hours of operation. Emission factors are from the

OFFROAD2006 model. The emission factors are shown in Table 26. Detailed emission factor derivation calculations and the OFFROAD2006 output are contained in Appendix G.

Table 26
Emission Factors for TRUs and Reefer Cars
Commerce Rail Yard

Equipment Type	Emissions (g/hp-hr-unit)[1]				
	HC[2]	CO	NOx	DPM	SOx[3]
TRU	2.85	6.78	6.43	0.71	0.07
Reefer Car	3.23	7.49	6.71	0.79	0.07

Notes:
1. Emission factors from OFFROAD2006 model.
2. Evaporative emissions from this source are negligible.
3. Emission factor based on a Diesel fuel sulfur content of 130 ppm.

B. TAC Emissions by Source Type

TAC emission calculations for each source type were based on the site-specific equipment inventory (shown in Part V of this report), equipment activity data (shown in Part VI of this report), and the source-specific emission factors shown in Part VII.A above. Criteria pollutant emissions are presented in a separate report.

Emissions from locomotive operations were based on the emission factors shown in Tables 17 and 18, the number of events, the number of locomotives per consist, duration, and duty cycle of different types of activity. Table 27 shows the duty cycles assumed for different types of activities.

Table 27
Locomotive Duty Cycles
Commerce Rail Yard

Activity	Duty Cycle
Through Train Movement	EB: N4 – 100%; WB: N3- 100%
Movements within the Yard	N1 – 50%, N2- 50%
Yard Operations	EPA Switch Duty Cycle[1]

Notes:
1. EPA (1998) Regulatory Support Document

For locomotive models and tiers for which specific emission factors were not available, the emissions for the next lower tier were used, or the next higher tier if no lower tier data were available. Emission factors for the "average locomotive" for different types of activity were developed from the emission factors and the actual locomotive model and technology distributions for that activity. Separate distributions were developed for eight types of activity: through trains (including through power moves); intermodal arrival; intermodal departures; other trains; arriving power moves; departing power moves; east end yard operations; and west end yard operations. Table 28 shows the DPM emission estimates for the different types of activities.

Table 28
DPM Emissions from Locomotives
Commerce Rail Yard

Activity	DPM Emissions (tpy)
Through trains	0.36
Intermodal trains	0.49
Other trains	0.36
Power moves	0.07
Yard operations	1.90
Service and Shop Idling	1.38
Load tests	0.32
Total	**4.87**

Notes:
1. See Table 1 for equipment specifications.
2. See Tables 8 and 9 for activity data.
3. See Table 17 and 18 for emission factors.
4. Emissions from yard operations are based on two sets of switcher locomotives operating between 7 AM and 11 PM daily, the EPA Switch Duty Cycle, and the emission factors shown in Table 17.
5. See Appendices A-3 and A-4 for detailed emission calculations. The calculations of sulfur adjustments are shown in Appendix A-7.

DPM emissions from on-road Diesel-fueled trucks are shown in Table 29. DPM emissions from HHD Diesel-fueled trucks and CHE are shown in Tables 30 and 31, respectively. DPM emissions from heavy equipment are shown in Table 32. Table 33 summarizes the TAC emissions from the gasoline storage tank. As discussed above, there are no TAC emissions from the Diesel storage tanks. TAC emissions from the WWTP are summarized in Table 34. DPM emissions from the Diesel-fueled TRUs and reefer cars are shown in Table 35. As discussed above, there are no TAC emissions from the sand tower. Detailed emission calculations for each source group are contained in Appendix H.

Table 29
DPM Emissions from On-Road Diesel-Fueled Trucks
Commerce Rail Yard

	Emissions (tpy)		
Pollutant	Traveling Mode	Idling Mode	Total
DPM	0.02	0.00	0.02

Notes:
1. See Table 2 for equipment specifications.
2. See Table 10 for activity data.
3. See Table 19 for emission factors.

Table 30
DPM Emissions from HHD Diesel-Fueled Trucks
Commerce Rail Yard

	Emissions (tpy)		
Pollutant	Traveling Mode	Idling Mode	Total
DPM	1.41	0.59	1.99

Notes:
1. See Part V for equipment specifications.
2. See Tables 11 and 12 for activity data.
3. See Table 20 for emission factors.

Table 31
DPM Emissions from Cargo Handling Equipment
Commerce Rail Yard

Equipment Type	Make/Model	Model Year	No of Units	DPM Emissions (tpy)
Forklift	Lull	1975	1	0.013
RTG	Mi Jack 1000R	1987	2	0.472
RTG	Mi Jack 1000R	1991	1	0.155
RTG	Mi Jack 850R	1996	1	0.059
RTG	Mi Jack 850R	1997	1	0.057
RTG	Mi Jack 1000R	2000	1	0.053
RTG	Taylor 9040	2003	2	0.070
RTG	Mi Jack 1000RC	2004	1	0.034
Top Pick	Raygo CH70	1986	1	0.007
Chassis Stacker	Taylor TCS90	1993	2	0.042
Chassis Stacker	Taylor TCS90	1995	1	0.020
Yard Hostler	Capacity TJ5100	1999	2	0.317
Yard Hostler	Capacity TJ5100	1999	1	0.159
Yard Hostler	Capacity TJ5100	2000	2	0.310
Yard Hostler	Capacity TJ5100	2001	6	0.907
Yard Hostler	Capacity TJ5100	2002	3	0.443
Yard Hostler	Capacity TJ5100	2003	1	0.091
Yard Hostler	Capacity TJ5100	2004	8	0.561
Yard Hostler	Capacity TJ5100	2006	3	0.168
Total			**40**	**3.94**

Notes:
1. See Table 3 for equipment specifications.
2. See Table 13 for activity data.
3. See Table 21 for emission factors.

Table 32
DPM Emissions from Heavy Equipment
Commerce Rail Yard

Equipment Type	Make/Model	Model Year	No of Units	DPM Emissions (tpy)
Crane	Lorain RT-450	*2000*	1	0.002
Forklift	Toyota	*1995*	3	0.027
Forklift	Caterpillar	*1995*	1	0.023
Forklift	Komatsu	1989	1	0.013
Trackmobile	Trackmobile TM4000	1990	1	0.064
Car Movers	NMC	1997	2	0.010
Total			**9**	**0.14**

Notes:
1. See Table 4 for equipment specifications.
2. See Table 14 for activity data.
3. See Table 23 for emission factors.
4. Items in italics are engineering estimates based on operator interviews.

Table 33
TAC Emissions from Gasoline Storage Tank
Commerce Rail Yard

CAS	Chemical Name	Emissions (tpy)
540841	2,2,4-trimethylpentane	0.0021
71432	Benzene	0.0006
110827	Cyclohexane	0.0017
100414	Ethylbenzene	0.0002
78784	Isopentane	0.0612
98828	Isopropylbenzene (cumene)	0.0000
108383	m-Xylene	0.0006
110543	n-Hexane	0.0025
95476	o-Xylene	0.0002
106423	p-Xylene	0.0002
108883	Toluene	0.0028
Total		**0.0720**

Notes:
1. See Table 5 for equipment specifications.
2. See Table 15 for activity data.
3. See Table 23 for emission factors.

Table 34
TAC Emissions from the Wastewater Treatment Plant
Commerce Rail Yard

Pollutant	Emissions (tpy)
Benzene	4.73×10^{-5}
Bis (2-ethylhexyl) Phthalate	2.33×10^{-6}
Bromomethane	8.30×10^{-5}
Chloroform	5.81×10^{-5}
Ethylbenzene	2.82×10^{-4}
Methylene Chloride	9.96×10^{-4}
Toluene	3.24×10^{-4}
Xylene	5.81×10^{-4}
Total	$\mathbf{2.37 \times 10^{-3}}$

Notes:
1. See Part V for equipment description.
2. See Part VI for activity data.
3. See Table 25 for emission factors.

Table 35
DPM Emissions from TRUs and Reefer Cars
Commerce Rail Yard

Equipment Type	DPM Emissions (tpy)
TRU	0.18
Railcar	0.09
Total	**0.27**

Notes:
1. See Part V for equipment specifications.
2. See Table 16 for activity data.
3. See Table 26 for emission factors.

C. Facility Total Emissions

Facility-wide DPM emissions are shown in Table 36. Facility-wide TAC emissions are shown in Table 37.

Table 36
Facility-Wide Diesel Particulate Emissions
Commerce Rail Yard

Source	Emissions (tpy)
Locomotives[1]	4.87
On-Road Diesel-Fueled Trucks[2]	0.02
HHD Diesel-Fueled Trucks[3]	1.99
Cargo Handling Equipment[4]	3.94
Heavy Equipment[5]	0.14
TRUs and Reefer Cars[6]	0.27
Total	**11.23**

Notes:
1. See Table 28.
2. See Table 29.
3. See Table 30.
4. See Table 31.
5. See Table 32.
6. See Table 35.

Table 37
Facility-Wide TAC Emissions
Commerce Rail Yard

CAS	Chemical Name	Emissions (tpy)		
		Gasoline Tank[1]	WWTP[2]	Total
540841	2,2,4-trimethylpentane	0.002	-	0.002
71432	Benzene	0.001	0.000	0.001
	Bis (2-ethylhexyl) Phthalate	-	0.000	0.000
	Bromomethane	-	0.000	0.000
67663	Chloroform	-	0.000	0.000
110827	Cyclohexane	0.002	-	0.002
100414	Ethylbenzene	0.000	0.000	0.000
78784	Isopentane	0.061	-	0.061
98828	Isopropylbenzene (cumene)	0.000	-	0.000
108383	m-Xylene	0.001	-	0.001
110543	n-Hexane	0.003	-	0.003
95476	o-Xylene	0.000	-	0.000
106423	p-Xylene	0.000	-	0.000
108883	Toluene	0.003	0.000	0.003
1330207	Xylene (total)	0.001	0.001	0.002
Total		**0.072**	**0.001**	**0.073**

Notes:
1. See Table 33.
2. See Table 34.

PART VIII: RISK SCREENING CALCULATIONS

As discussed in Part IV of this report and agreed upon with the CARB, de minimis sources, based on weighted health risk, were identified in the inventory, but were not included in the modeling analysis. De minimis sources are the individual source categories that represent less than 3 percent of the facility-total weighted-average site health impacts (determined separately for cancer risk and non-cancer chronic health hazard). Total exclusions for all de minimis sources did not exceed 10 percent of the facility-total weighted-average site health impacts.

The OEHHA unit risk factor for each pollutant was multiplied by the annual emissions of that pollutant to generate a risk index value for each source. Each source-specific risk index was divided by the facility total risk index to get the fractional contribution to the total risk for each source. The cancer risk, the non-cancer health hazard index, and the fractional contribution to the cancer risk and non-cancer chronic health hazard for each source is summarized in Table 38. Detailed cancer risk and non-cancer health hazard index calculations are in Appendix I.

Table 38
Summary of Weighted Risk by Source Category
Commerce Rail Yard

Source	Cancer Risk		Non-Cancer Chronic Health Hazard	
	Risk Index Value	Percent of Total Risk	Health Hazard Index Value	Percent of Total Hazard
Locomotives	1.46×10^{-3}	43.38	2.44×10^{1}	31.43
On-Road Diesel-Fueled Trucks	5.20×10^{-6}	0.15	8.66×10^{-2}	0.11
HHD Diesel-Fueled Trucks	5.98×10^{-4}	17.75	9.97	12.86
Cargo Handling Equipment	1.18×10^{-3}	35.04	1.97×10^{1}	25.39
Heavy Equipment	4.16×10^{-5}	1.24	6.94×10^{-1}	0.90
Gasoline Storage Tank	1.71×10^{-8}	0.00	2.03×10^{1}	26.14
WWTP	1.68×10^{-9}	0.00	1.09	1.40
TRUs and Reefer Cars	8.23×10^{-5}	2.44	1.37	1.77
Total	$\mathbf{3.37 \times 10^{-3}}$	**100**	$\mathbf{7.63 \times 10^{1}}$	**100**

Sources that represent less than 3 percent each of the facility-total weighted-average cancer risk and non-cancer chronic health hazard, as shown in Table 38, are de minimis. Table 39 lists the de minimis sources for the Commerce Yard.

Table 39
Summary of De Minimis Sources
Commerce Rail Yard

De Minimis Sources for Cancer Risk	De Minimis Sources for Non-Cancer Chronic Health Hazard
On-Road Diesel-Fueled Trucks WWTP Gasoline Storage Tank Heavy Equipment TRUs and Reefer Cars	On-Road Diesel-Fueled Trucks WWTP Heavy Equipment TRUs and Reefer Cars

Sources that are de minimis for both cancer risk and non-cancer chronic health hazard (i.e., on-road Diesel-fueled trucks, WWTP, and TRUs and reefer cars) are not included in the dispersion modeling analysis. At the request of CARB, heavy equipment was included in the dispersion modeling analysis, notwithstanding their de minimis risk contribution.

PART IX: AIR DISPERSION MODELING

An air dispersion modeling analysis was conducted for the Commerce Yard. The purpose of the analysis was to estimate ground-level concentrations of DPM and other TACs, emitted from Yard operations, at receptor locations near the Yard. Air dispersion modeling was conducted in accordance with the *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006) and UPRR's *Modeling Protocol* (August 2006). Each aspect of the modeling is further described below.

A. Model Selection and Preparation

1. Modeled Sources and Source Treatment

As discussed in Part VIII, only sources that represent more than 3 percent of the facility-total weighted-average site health impacts (determined separately for cancer risk and non-cancer chronic health hazard) were included in the dispersion modeling analysis. At the request of CARB, heavy equipment was included as well, notwithstanding their de minimis risk contribution. Emissions from mobile sources, low-level cargo handling equipment, heavy equipment, and moving locomotives were simulated as a series of volume sources along their corresponding travel routes and work areas. Idling and load testing of locomotives and elevated cargo handling equipment (cranes) were simulated as a series of point sources within the areas where these events occur. The elevation for each source was interpolated from a 50 m grid of USGS terrain elevations. Table 40 shows the sources that were included in the modeling analysis and treatment used for each source. Assumptions used to spatially allocate emissions from locomotive operations within the Yard are included in Appendix A-4. Assumptions used to spatially allocate emissions from non-locomotive sources are contained in Appendix J.

Table 40 **Source Treatment for Air Dispersion Modeling** **Commerce Rail Yard**	
Source	Source Treatment
Gasoline Storage Tank	Point
HHD Diesel-Fueled Trucks (idling)	Volume
HHD Diesel-Fueled Trucks (traveling)	Volume
Locomotives (idling)	Point
Locomotives (traveling)	Volume
Cargo Handling Equipment (low level)	Volume
Cargo Handling Equipment (RTGs)	Point
Heavy Equipment (idling)	Volume
Heavy Equipment (traveling)	Volume
Notes: 1. See Figure 3 for source locations.	

2. <u>Model Selection</u>

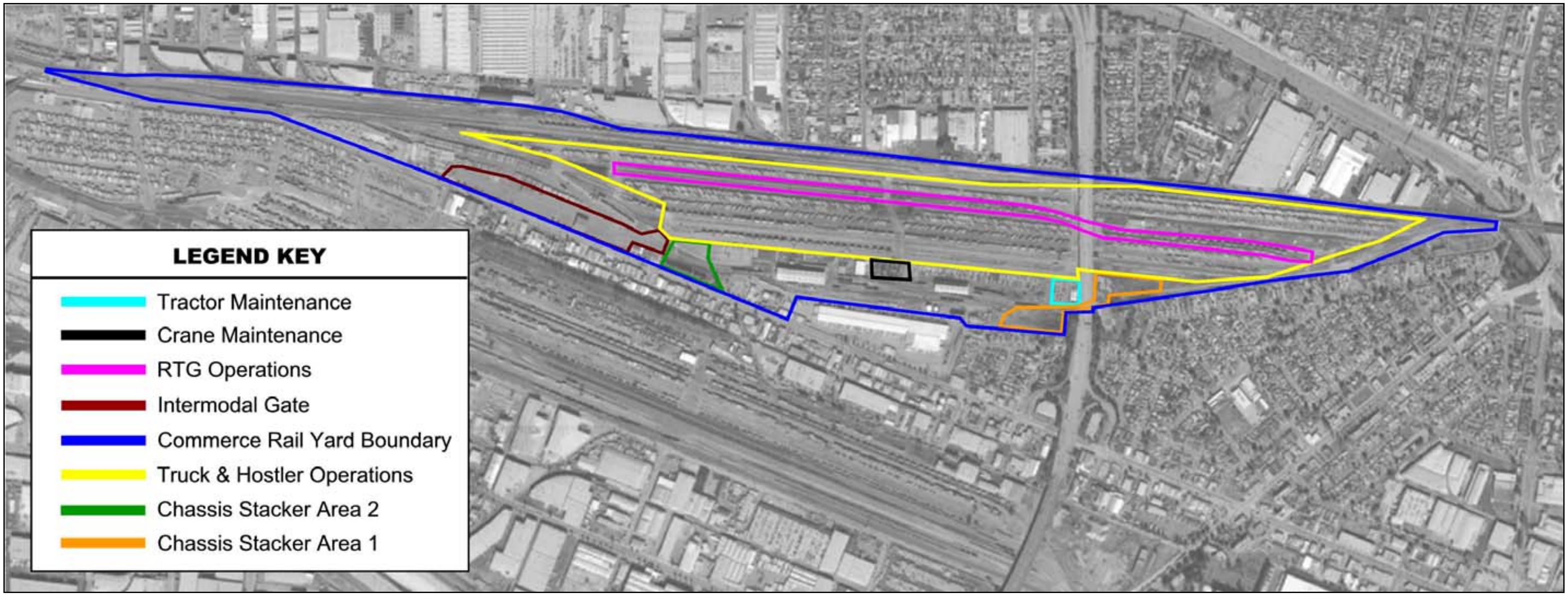
Selection of air dispersion models depends on many factors, including the type of emissions source (point, line, or volume) and type of terrain surrounding the emission source. The USEPA-approved guideline air dispersion model, AERMOD, was selected for this project. AERMOD is recommended by EPA as the preferred air dispersion model, and is the recommended model in the CARB's *Health Risk Assessment Guidance for Rail Yard and Intermodal Facilities* (July 2006).

AERMOD is a steady-state,[9] multiple-source, Gaussian dispersion model designed for use with emission sources situated in terrain where ground elevations can exceed the release heights of the emission sources (i.e., complex terrain).[10] AERMOD was used with hourly wind speed and direction data from the Lynwood station operated in the CARB network, and temperature and cloud cover data from the Los Angeles downtown USC station operated by the National Weather Service. AERMOD used these parameters to select the appropriate dispersion coefficients.

[9] The term "steady-state" means that the model assumes no variability in meteorological parameters over a one-hour time period.

[10] Federal Register, November 9, 2005; Volume 70, Number 216, Pages 68218-68261.

Figure 3
Source Locations



Standard AERMOD control parameters were used, including stack-tip downwash, non-screening mode, non-flat terrain, and sequential meteorological data check. Following USEPA guidance, the stack-tip downwash option adjusted the effective stack height downward following the methods of Briggs (1972) for stack exit velocities less than 1.5 times the wind speed at stack top.

Two AERMET preprocessors (Stages 1 and 2, and Stage 3) were used to prepare meteorological data for use in AERMOD. Albedo and Bowen ratio[11] were estimated in multiple wind direction sectors surrounding the Yard, while surface roughness from similar sectors around the meteorological monitoring site was used in the model. This separation was based on the fact that atmospheric turbulence induced by surface roughness around the meteorological monitoring tower affects the resulting wind speed profile used by AERMOD to represent conditions at the Yard, while the albedo and Bowen ratio around the Yard are more appropriate to characterize land use conditions surrounding the area being modeled.

As suggested by USEPA (2000), for purposes of determining albedo and Bowen ratio the surface characteristics were specified in sectors no smaller than a 30-degree arc. Specifying surface characteristics in narrower sectors becomes less meaningful because of expected wind direction variability during an hour, as well as the encroachment of characteristics from the adjacent sectors with a one-hour travel time. Use of weighted-average[12] characteristics by surface area within a 30-degree (or wider) sector made it possible to have a unique portion of the surface significantly influence the properties of the sector that it occupies. The length of the upwind fetch for defining the nature of the turbulent characteristics of the atmosphere in each sector surrounding the source location

[11] The albedo of a specified surface is the ratio of the radiative flux reflected from the surface to the radiative flux incident on the surface. Flux is the amount of energy per unit time incident upon or crossing a unit area of a defined flat plane. For example, the albedo for snow and ice varies from 80% to 85% and the albedo for bare ground from 10% to 20%. Bowen ratio is the ratio of heat energy used for sensible heating (conduction and convection) of the air above a specified surface to the heat energy used for latent heating (evaporation of water or sublimation of snow) at the surface. The Bowen ratio ranges from 0.1 for the ocean surface to more that 2.0 for deserts; negative values are also possible.

[12] Weighting was based on wind direction frequency, as determined from a wind rose.

was 3 kilometers as recommended by Irwin (1978) and USEPA's *Guideline on Air Quality Models*.[13]

3. Modeling Inputs

Modeling was based on the annual average emissions for each source as discussed in Part VII B above Diurnal and/or seasonal activity scalars were applied to locomotive activities, cargo handling equipment activities, and HHD truck operations. The following profiles were used in the modeling. See Appendix A-3 for the profiles used and Appendix K for a description of the methods used to develop these profiles.

- A seasonal/diurnal activity profiles was calculated for locomotive idling based on the number of arrivals and departures in each hour of the day and the number of arriving and departing trains in each season. Each hourly factor was based on the number of arrivals and departures in that hour, the number of arrivals in the preceding two hours, and the number of departures in the following two hours. This approach captures the idling times for consists on arrival and departure. These factors were applied to consist idling for arriving and departing trains, and idling at the service track.
- A seasonal/diurnal activity profile was calculated for in-yard locomotive movements of road power using the same approach as for idling. In this case, however, only the number of arriving and departing trains in a single hour was used for that hour's factor.
- A diurnal profile was used for switching operations and pre-maintenance load testing. Yard switching operations take place between 7 AM and 11 PM, and pre-maintenance load testing takes place only between 7 AM and 3 PM.
- A seasonal/diurnal profile was applied to locomotive load test emissions occurring at the east end of the shop based on monthly service release data and the 0700h to 1500h periods when testing occurs at that location. Only the service release seasonal factors were applied to other load test emissions.
- The seasonal distribution for arriving and departing trains was applied to both cargo handling equipment activity and HHD truck activity at the Yard.

[13] USEPA (1986), and published as Appendix W to 40 CFR Part 51 (as revised).

The volume source release heights and vertical dispersion parameters (σ_z) were those used by CARB for the Truck Stop Scenario in Appendix VII of the Diesel Risk Reduction Plan for mobile vehicles and equipment other than locomotives. For locomotives, the release height and σ_z values used were those developed by CARB for daytime and nighttime locomotive movements in the Roseville Risk Assessment modeling. Stack parameters used to create the AERMOD input file for locomotive operations are shown in Table 41. Table 42 summarizes the modeling inputs used to create the AERMOD input file for each non-locomotive source at the Yard.

Table 41
Locomotive Modeling Inputs
Commerce Rail Yard

Source	Point/Idling Source Parameters				Volume Source Parameters		
	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Temp (° K)	σ_z (m)	σ_y[5] (m)	Release Height (m)
Locomotives (idling and load tests)[1]							
Road power at all yards-SD7x[2]	4.6	0.625	3.1	364	-	-	-
Load tests – N1[3]	4.6	0.625	8.0	420	-	-	-
Load tests – N8[3]	4.6	0.625	36.6	589	-	-	-
Yard locomotives CM-E-GP4x	4.6	0.666	3.7	352	-	-	-
Yard locomotives CM-W-GP60	4.6	0.625	3.1	362	-	-	-
Locomotives (traveling)[4]							
Day[5]	-	-	-	-	2.6	20-50	5.6
Night[5]	-	-	-	-	6.79	20-50	14.6

Notes:
1. Stack parameters for stationary locomotives were taken from the CARB Roseville modeling analysis.
2. Idling road power stack parameters are those of the most prevalent locomotive model (SD-7x).
3. Load test stack parameters are those of the most prevalent locomotive model (SD-7x).
4. All locomotive movements for road power and yard locomotives while working are the day and night volume source parameters for moving locomotives from the CARB Roseville modeling analysis.
5. Lateral dispersion coefficient (σ_y) for moving locomotive volume sources was set to values between 20 and 50 m, depending on the spacing of sources in different areas of the yard and proximity to yard boundaries.

Table 42
Non-Locomotive Modeling Inputs
Commerce Rail Yard

Source	Point/Idling Source Parameters				Volume Source Parameters		
	Stack Height (m)	Stack Diameter (m)	Exit Velocity (m/s)	Temp (° K)	σ_z (m)	σ_y[5] (m)	Release Height (m)
HHD Diesel-fueled Trucks	-	-	-	-	1.39	20-50	4.15
Cranes[1]	12.5	0.13	20	644.3	-	-	-
RTGs[1]	12.5	0.13	20	644.3	-	-	-
Top Picks[2]	-	-	-	-	1.39	20-50	4.15
Forklifts[2]	-	-	-	-	1.39	20-50	4.15
Yard Hostlers[2]	-	-	-	-	1.39	20-50	4.15
Chassis Stackers[2]	-	-	-	-	1.39	20-50	4.15
Trackmobile[2]	-	-	-	-	1.39	20-50	4.15
Car Movers/Tugs[2]	-	-	-	-	1.39	20-50	4.15

Notes:
1. Stack parameters from equipment manufacturers.
2. Low level sources treated as volume sources using the release height and vertical dispersion parameter (σ_z) from the CARB Diesel Risk Reduction Plan (Sept. 13, 2000), Appendix VII, Table 2 (Truck stop scenario).
3. Low level source lateral dispersion parameter (σ_y) set to a value between 20 and 50 meters based on spacing between sources and proximity to the yard boundary.

4. Meteorological Data Selection

The Yard does not monitor meteorological variables on site. Data from the Lynwood station, operated by the SCAQMD in the CARB network and the Los Angeles downtown USC station, operated by the National Weather Service, were used for this project.

To the extent that airflow patterns are spatially variable due to elevated terrain and land-sea effects near the coast, judgment was exercised to select the monitoring stations that are most representative of conditions at the Commerce Yard.

Because rail yards, especially emissions from locomotives, tend to be aligned linearly along the main track routes, the directions of prevailing surface winds were important to achieve representativeness of model predictions in the near field. For longer transport distances (e.g., 1 to 10 km), surface winds were still the primary consideration, with atmospheric stability also playing an important role. Due to the relatively low release heights and limited plume rise of rail yard sources, modeled concentrations are relatively insensitive to mixing heights, temperatures, and vertical temperature and wind profiles.

To ensure consistency between the UPRR and BNSF dispersion modeling analyses for yards in the Commerce area, the meteorological data used by UPRR for the Commerce Yard was the same as that selected by BNSF for their nearby Yard. Based on ENVIRON's evaluation of available meteorological data,[14] including the above criteria for representativeness, wind speed and direction data from Lynwood, and temperature and cloud cover data from the Los Angeles USC station, were processed in AERMET, the meteorological preprocessor for AERMOD. The selection of Lynwood was made from those stations[15] for which surface wind data were available for the same years as NWS upper air data. This limited the number of surface stations that could be considered. Additional surface stations in comparable proximity to the Yard include the

[14] ENVIRON. *Meteorological Data Selection and Processing Methodology for 2006 BNSF Designated Rail Yards*, Report 06-12910J, July 25, 2006.

[15] Aside from NWS surface meteorological data available from Los Angeles and Ontario International Airports, the SCAQMD provided wind speed and direction data from 2002 through 2005 for the following stations they maintain: Lynwood, Downtown Los Angeles [Not the same as the Downtown Los Angeles station at USC], Long Beach, Pico Rivera, Pomona, Rubidous and Fontana.

AQMD monitoring stations in Vernon and West Los Angles, but their data for the years of the upper air data records are not currently available in electronic form suitable for preprocessing with AERMET.

Four years, 2002 through 2005, of meteorological data from Lynwood were processed with AERMET to evaluate the completeness and quality of each year for AERMOD modeling. It is expected that year-to-year variability would not cause significant differences in the modeled air quality impacts, and hence would justify needing to subject the full set of receptors to only one year of meteorological data. The meteorological data from 2005 were selected for rail yard dispersion modeling because they had adequate completeness and quality, and were the most recent year available.

Based on the above criteria for representativeness, wind speed and direction data from Lynwood, and temperature and cloud cover data from the Los Angeles USC station were processed in AERMET, the meteorological preprocessor for AERMOD.

5. Model Domain and Receptor Grids

A domain size of 20 km by 20 km and coarse receptor grid of 500 m x 500 m was used for the modeling analysis. A fine grid of 50 m x 50 m surrounding the Yard was used for modeling within 400 m of the fence line. A medium-fine grid of 100 m x 100 m was used for receptors between 400 and 800 m of the fence line around the fine grid network, and a medium grid of 200 m x 200 m was used for receptor distances between 800 and 1500 m.

All receptors were identified by UTM coordinates. United States Geological Survey (USGS) 7.5 Minute digital elevation model (DEM) data were used to identify terrain heights at each receptor. Figures 4 and 5 show the outline of the Yard along with the coarse and fine receptor grids.

Sensitive receptors, consisting of hospitals, schools, day-care centers, and elder care facilities, within a 1-mile radius of the Yard, were identified. Table 43 lists the address, elevations, and UTM coordinates for each sensitive receptor. Figure 6 shows the outline of the Yard and the location of each sensitive receptor identified in Table 43.

Table 43
Sensitive Receptor Locations
Commerce Rail Yard

Receptor	Address	Elevation (m)	UTM-E (m)	UTM-N (m)
Bandini Elementary School	2318 Couts Ave, Los Angeles, CA 90040	46	392138	3763449
Eastman Avenue Elementary School	4112 E Olympic Blvd, Los Angeles, CA 90023	59	390536	3764795
Maywood New Elementary #5	5200 Cudahy Ave, Maywood, CA 90270	47	390608	3762090
Ford Blvd Elementary School	1112 S Ford Blvd, Los Angeles, CA 90022	54	391795	3764900
Winter Gardens School	1277 Clela Ave, Los Angeles, CA 90022	51	392614	3764448
Stevenson Jr High School	725 S Indiana St, Los Angeles, CA 90023	77	389905	3765635
Rowan Ave Elementary	600 S Rowan Ave, Los Angeles, CA 90023	82	390386	3765874
Apostolic Christian Academy	4818 Hubbard St, Los Angeles, CA 90022	62	392594	3765414
Rosewood Park Elementary School	2353 Commerce Way, Los Angeles, CA 90040	44	393263	3763216
Resurrection School	3360 Opal St, Los Angeles, CA 90023	68	388746	3765244
Lorena Street Elementary	1015 S Lorena St, Los Angeles, CA 90023	75	388926	3765569
Central City Value School	5156 Whittier Blvd, Los Angeles, CA 90022	57	393027	3764948
Dena Elementary	1314 S Dacotah St, Los Angeles, CA 90023	67	388231	3765108
Garfield High School	5101 E 6th St, Los Angeles, CA 90022	65	392945	3765614
St Alphonsus Elementary School	552 S Amalia Ave, Los Angeles, CA 90022	64	393302	3765533
Humphreys St Elementary	500 S Humphreys Ave, Los Angeles, CA 90022	75	391934	3765885
Early Childhood Center	1340 S Bonnie Beach Pl, Los Angeles, CA 90023	56	390936	3764489
Mexican American Opportunity	4457 Telegraph Rd, Los Angeles, CA 90023	56	391511	3764780
Maywood Child Development Center	4803 E 58th St, Maywood, CA 90270	44	391139	3761396
Plaza Child Observation Center	648 S Indiana St, Los Angeles, CA 90023	83	389932	3765811
Mexican-American Opportunity	972 Goodrich Blvd, Los Angeles, CA 90022	55	393407	3764743
Perez Family Child Care	5835 Bartmus St, Los Angeles, CA 90040	46	393704	3762944
ABC Child Development Center	702 S Gerhart Ave, Los Angeles, CA 90022	61	394142	3765005
Los Angeles Community Hospital	4081 E Olympic Blvd, Los Angeles, CA 90023	61	390432	3764901
Buena Ventura Convalescent Hospital	1016 S Record Ave, Los Angeles, CA 90023	64	390822	3765232
East LA Doctors Hospital	4060 Whittier Blvd, Los Angeles, CA 90023	68	390672	3765427
Los Angeles Family Medical Clinic	3410 Whittier Blvd, Los Angeles, CA 90023	88	389139	3765862

Notes:
1. UTM Coordinates are in Zone 11, NAD 83.

Figure 4
Coarse Modeling Grid
Commerce Rail Yard

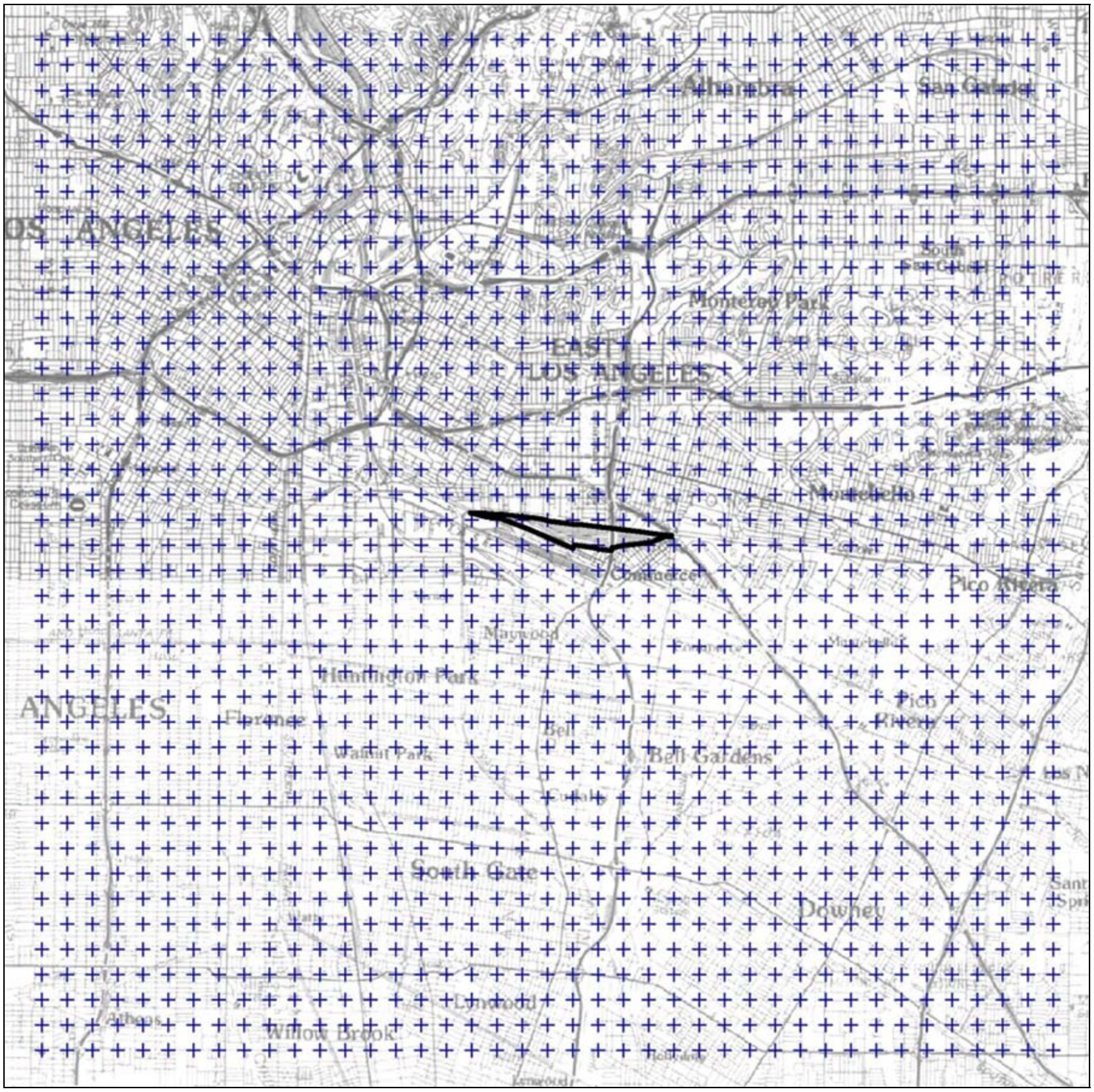


Figure 5
Fine Modeling Grid
Commerce Rail Yard

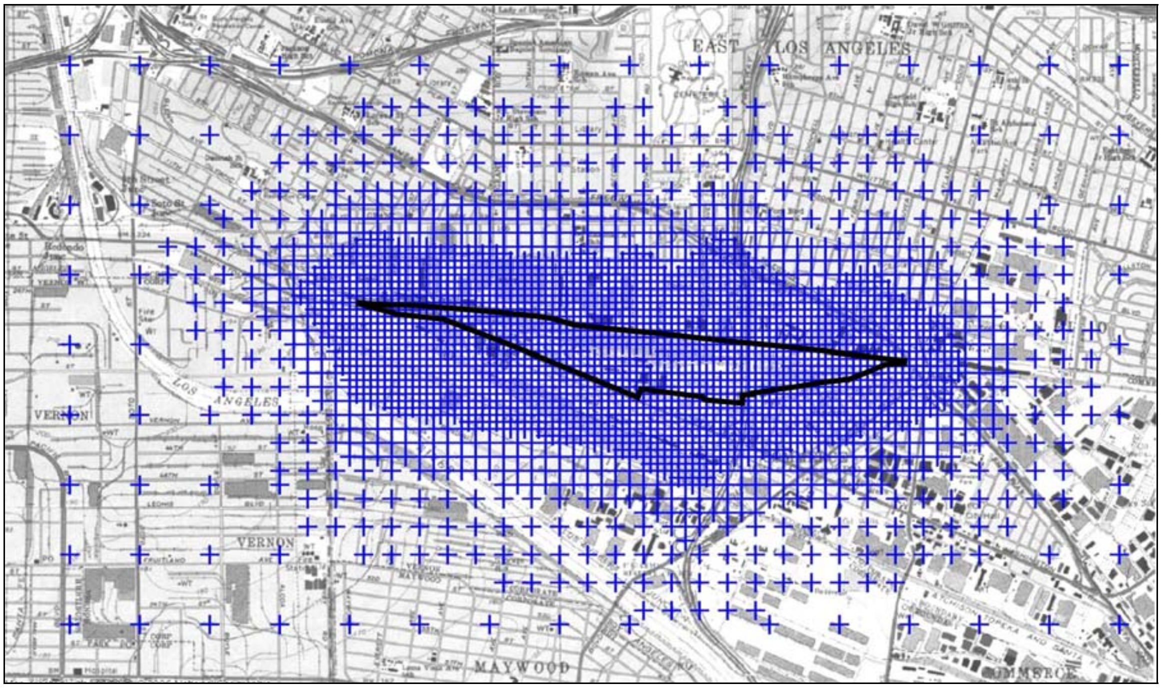
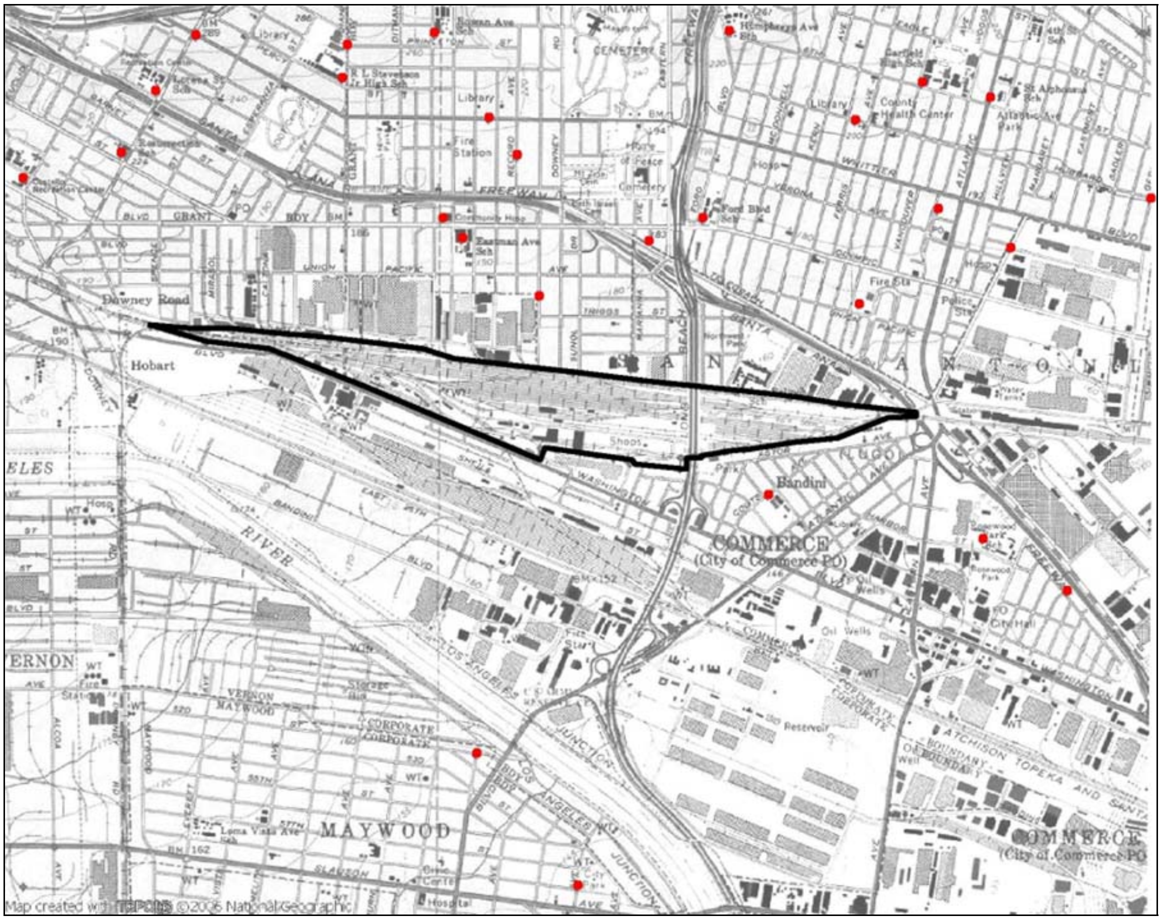


Figure 6
Sensitive Receptors
Commerce Rail Yard



6. Dispersion Coefficients

Dispersion coefficients are used in air dispersion models to reflect the land use over which the pollutants are transported. The area surrounding the Yard and the nearby BNSF rail yard was divided into sectors to characterize the albedo and Bowen ratio. The area surrounding the Lynwood meteorological monitoring station was similarly divided into sectors to characterize surface roughness. These parameters were provided along with the meteorological data to the AERMET software. The resulting meteorological input file allows AERMOD to select appropriate dispersion coefficients during its simulation of air dispersion. AERMOD also provides an urban input option to use the overall size of the Standard Metropolitan Statistical Area that contains the emission source (i.e., the Yard) in accounting for the urban heat island effect on the nocturnal convective boundary layer height. If the option is not selected, AERMOD defaults to rural dispersion coefficients. If the urban option is selected, but no surface roughness is specified (not to be confused with the surface roughness parameters already specified for sectors around the meteorological monitoring station and input to AERMET), AERMOD assigns a default "urban" surface roughness of 1 meter. For the Commerce Yard, AERMOD was run with the urban option. Based on CARB and USEPA guidance,[16] namely "*For urban areas adjacent to or near other urban areas, or part of urban corridors, the user should attempt to identify that part of the urban area that will contribute to the urban heat island plume affecting the source,*" the area encompassed by the surrounding Los Angeles Standard Metropolitan Statistical Area (SMSA) was considered to determine the urban heat island effect on the nocturnal convective boundary layer height. The population of this SMSA is approximately 13,000,000,[17] and the surface roughness that characterizes this metropolitan area was set to the URBANOPT default of 1 m. See Appendix L for additional discussion of this issue.

[16] AERMOD Implementation Guide, September 27, 2005, http://www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide.pdf

[17] U.S. Census Bureau, Statistical Abstract of the United States: 2006 (http://www.census.gov/compendia/statab/population/pop.pdf) -- Table 26 (p. 30) gives 2004 Los Angeles-Long Beach-Santa Ana MSA population of 12,925,000.

7. Building Downwash

Building downwash effects were considered for the Yard. Stack-tip downwash adjusted the effective stack height downward following the methods of Briggs (1972) when the stack exit velocity was less than 1.5 times the wind speed at stack top. The locomotives are the only structures in the Yard of sufficiently large size and close enough proximity to the modeled emission sources (i.e., their own stacks) to be entered into the Building Profile Input Program (BPIP) with one set of dimensions for a "standard" locomotive (24.2 m. long x 4.0 m. wide x 4.6 m. high).

B. Modeling Results

The AERMOD input and output files have been provided to CARB in an electronic format.

C. Demographic Data

Demographic data files have been provided to CARB in an electronic format. See Appendix M for a description of the data.

PART X. REFERENCES

Briggs, G.A. (1972). *Discussion on Chimney Plumes in Neutral and Stable Surroundings*. Atmos. Environ. 6:507-510.

CARB (2000). *Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles.* (Available at *www.arb.ca.gov/diesel/documents/rrpapp.htm*)

CARB (2003). *Staff Report: Initial Statement of Reasons for Proposed Rule Making for the Airborne Toxic Control Measure for In-use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets, and Facilities Where TRUs Operate.* (Available at *www.arb.ca.gov/regact/trude03/isor.pdf*)

CARB (2004). *Roseville Rail Yard Study.* (Available at *www.arb.ca.gov/diesel/documents/rrstudy/rrstudy101404.pdf*)

CARB (2006). *Health Risk Assessment Guidance for Rail Yards and Intermodal Facilities.* (Available at *www.arb.ca.gov/railyard/hra/071806hra_guideline.pdf*)

CARB (2006). *EMFAC-WD2006 Model.* (Available at *www.arb.ca.gov/msei/onroad/latest_version.htm*)

CARB (2006). *OFFROAD2006 Model*. (Available at *www.arb.ca.gov/msei/offroad/offroad.htm*)

CARB (2006). *Rail Yard Emission Inventory Methodology*. (Available at *www.arb.ca.gov/railyard/hra/071806hra_eim.pdf)*

Ireson, R.G., M.J. Germer, L.A. Schmid (2005). *Development of Detailed Rail yard Emissions to Capture Activity, Technology, and Operational Changes*. Proceedings of the USEPA 14th Annual Emission Inventory Conference, Las Vegas NV, April 14, 2006. (Available at *www.epa.gov/ttn/chief/conference/ei14/session8/ireson.pdf*)

Irwin, J.S. (1978). *Proposed Criteria for Selection of Urban Versus Rural Dispersion Coefficients*. Staff Report. Meteorology and Assessment Division, U.S. Environmental Protection Agency, Research Triangle Park, NC. (Air Docket Reference No. II-B-8 for the Fourth Conference on Air Quality Modeling).

Nappo, C. J. et al. (1982). *The Workshop on the Representativeness of Meteorological Observations*, June 1981, Boulder, CO. Bulletin Amer. Meteor. Soc., Vol. 63, No. 7, pp. 761-764. American Meteorological Society, Boston, MA.

Trinity Consultants (2004). *Air Emission Inventory and Regulatory Analysis for Commerce Yard.*

USEPA (1986). *Guideline on Air Quality Models (Revised)*. U.S. EPA-45/2-78-027R, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

USEPA (1987a). *Supplement A to the Guideline on Air Quality Models (Revised).* Office of Air Quality Planning and Standards, Research Triangle Park, NC.

USEPA (1987b). *Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD).* Office of Air Quality Planning and Standards, and Office of Research and Development, Research Triangle Park, NC.

USEPA (1995). *Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources.* (Available at www.epa.gov/ttn/chief/ap42/)

USEPA (1998). *Locomotive Emission Standards -- Regulatory Support Document.* (Available at *www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf*).

USEPA (2000). *Meteorological Monitoring Guidance for Regulatory Modeling Applications*. Publication No. EPA-454/R-99-005. Office of Air Quality Planning & Standards, Research Triangle Park, NC. (PB 2001-103606) (Available at *www.epa.gov/scram001/*)

USEPA (2004). *Final Regulatory Impact Analysis: Control of Emissions from Non-Road Diesel Engines.* U.S. EPA 420-R-04-007. Office of Air Quality Planning and Standards, Assessment and Standards Division, Research Triangle Park, NC.

USEPA (2005). *AERMOD Implementation Guide.* (Available at *www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide.pdf*).

Wong, W (undated). *Changes to the Locomotive Inventory*. Draft OFFROAD Modeling Change Technical Memo.

APPENDIX A

LOCOMOTIVE DATA

APPENDIX A-1

LOCOMOTIVE MODEL, TIER, AND
AUTO-START/STOP TECHNOLOGY
FREQUENCY BY TRAIN TYPE

Appendix A-1
Locomotive Model, Tier, and Auto-Start/Stop Technology Frequency by Train Type

Through Trains

# of EB arrivals 3446

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	4	1816	73	348	35	18	5	749	648	6	77
N	Y	0	2	0	0	1	0	0	0	0	45	0	0
0	N	0	0	23	2	83	1926	3	0	109	246	11	0
0	Y	0	0	0	0	5	7	0	0	0	46	0	0
1	N	0	0	0	0	0	374	0	0	0	1	0	0
1	Y	0	0	0	0	0	1568	0	0	0	111	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	402	0	0	0	938	0	0

# of EB departures 3446

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	4	1817	73	348	35	18	5	748	648	6	77
N	Y	0	2	0	0	1	0	0	0	0	45	0	0
0	N	0	0	23	2	83	1926	3	0	109	246	11	0
0	Y	0	0	0	0	5	7	0	0	0	46	0	0
1	N	0	0	0	0	0	374	0	0	0	1	0	0
1	Y	0	0	0	0	0	1568	0	0	0	111	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	402	0	0	0	937	0	0

# of WB arrivals 2190

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	1	1126	46	245	21	14	2	358	303	2	46
N	Y	0	0	0	0	0	0	0	0	0	16	0	0
0	N	0	0	8	1	47	968	3	0	65	130	8	0
0	Y	0	0	0	0	2	4	0	0	0	16	0	0
1	N	0	0	0	0	0	167	0	0	0	0	0	0
1	Y	0	0	0	0	0	706	0	0	0	46	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	227	0	0	0	563	0	0

Appendix A-1
Locomotive Model, Tier, and Auto-Start/Stop Technology Frequency by Train Type

# of WB departures 2190

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	1	1126	46	245	21	14	2	358	303	2	46
N	Y	0	0	0	0	0	0	0	0	0	16	0	0
0	N	0	0	8	1	47	968	3	0	65	130	8	0
0	Y	0	0	0	0	2	4	0	0	0	16	0	0
1	N	0	0	0	0	0	167	0	0	0	0	0	0
1	Y	0	0	0	0	0	706	0	0	0	46	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	227	0	0	0	563	0	0

Intermodal
# of EB arrivals 61

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	0	33	1	16	0	0	0	4	4	0	7
N	Y	0	0	0	0	0	0	0	0	0	0	0	0
0	N	0	0	0	0	1	26	0	0	0	1	1	0
0	Y	0	0	0	0	0	0	0	0	0	2	0	0
1	N	0	0	0	0	0	2	0	0	0	0	0	0
1	Y	0	0	0	0	0	11	0	0	0	2	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	0	0	0	0	7	0	0

# of WB arrivals 1205

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	1	185	22	148	12	5	0	303	278	0	18
N	Y	0	0	0	0	0	0	0	0	0	22	0	0
0	N	0	0	6	1	31	855	4	0	53	118	6	0
0	Y	0	0	0	0	1	9	0	0	0	9	0	0
1	N	0	0	0	0	0	178	0	0	0	0	0	0
1	Y	0	0	0	0	0	685	0	0	0	22	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	165	0	0	0	527	0	0

Appendix A-1
Locomotive Model, Tier, and Auto-Start/Stop Technology Frequency by Train Type

Intermodal

# of EB departures 1231

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	3	306	43	152	20	28	0	462	391	0	31
N	Y	0	1	0	0	0	0	0	0	0	33	0	0
0	N	0	0	16	1	32	948	6	0	79	137	13	0
0	Y	0	1	0	0	0	5	0	0	0	14	0	1
1	N	0	0	0	0	0	198	0	0	0	0	0	0
1	Y	0	0	0	0	0	779	0	0	0	56	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	180	0	0	0	539	0	0

# of WB departures 106

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	1	74	1	65	0	0	0	3	4	0	17
N	Y	0	0	1	0	0	0	0	0	0	0	0	0
0	N	0	1	0	0	10	13	0	0	3	1	0	0
0	Y	0	1	0	0	1	0	0	0	0	0	0	0
1	N	0	0	0	0	0	4	0	0	0	0	0	0
1	Y	0	0	0	0	0	9	0	0	0	3	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	1	0	0	0	6	0	0

Other Arrivals

# of EB arrivals 11

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	0	3	0	11	0	0	0	0	0	0	0
N	Y	0	0	0	0	0	0	0	0	0	0	0	0
0	N	0	0	0	0	0	2	0	0	0	0	0	0
0	Y	0	0	0	0	0	0	0	0	0	0	0	0
1	N	0	0	0	0	0	0	0	0	0	0	0	0
1	Y	0	0	0	0	0	1	0	0	0	0	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	1	0	0	0	1	0	0

Appendix A-1
Locomotive Model, Tier, and Auto-Start/Stop Technology Frequency by Train Type

# of WB arrivals 49

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	1	10	0	12	0	15	2	12	34	0	1
N	Y	0	0	0	0	0	0	0	0	0	1	0	0
0	N	0	0	0	0	1	14	2	0	0	20	4	0
0	Y	0	0	0	0	0	0	0	0	0	6	0	0
1	N	0	0	0	0	0	4	0	0	0	0	0	0
1	Y	0	0	0	0	0	10	0	0	0	19	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	1	0	0	0	2	0	0

Other Departures
# of EB departures 13

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	0	2	0	13	0	0	0	0	0	0	0
N	Y	0	3	0	0	0	0	0	0	0	0	0	0
0	N	0	0	0	0	1	2	0	0	0	0	0	0
0	Y	0	0	0	0	0	0	0	0	0	0	0	0
1	N	0	0	0	0	0	1	0	0	0	0	0	0
1	Y	0	0	0	0	0	2	0	0	0	0	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	0	0	0	0	2	0	0

# of WB departures 3

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	0	0	0	2	0	0	0	0	0	0	0
N	Y	0	0	0	0	0	0	0	0	0	0	0	0
0	N	0	0	0	0	0	0	0	0	0	0	0	0
0	Y	0	0	0	0	0	0	0	0	0	1	0	0
1	N	0	0	0	0	0	0	0	0	0	0	0	0
1	Y	0	0	0	0	0	0	0	0	0	0	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	1	0	0	0	1	0	0

Appendix A-1
Locomotive Model, Tier, and Auto-Start/Stop Technology Frequency by Train Type

Other Arrive and Depart

# of EB arrivals 565

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	66	30	191	1	541	1	2	0	8	16	0	180
N	Y	39	47	0	0	2	0	0	0	0	2	0	23
0	N	0	0	7	0	137	33	1	0	1	5	0	5
0	Y	0	0	0	0	0	0	0	0	0	0	0	8
1	N	0	0	0	0	0	8	0	0	0	0	0	0
1	Y	0	0	0	0	0	31	0	0	0	4	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	4	0	0	0	21	0	0

# of EB departures 565

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	66	30	186	1	539	1	2	0	10	16	0	178
N	Y	39	47	0	0	2	0	0	0	0	2	0	23
0	N	0	0	7	0	139	36	1	0	1	5	0	5
0	Y	0	0	0	0	0	0	0	0	0	0	0	8
1	N	0	0	0	0	0	11	0	0	0	0	0	0
1	Y	0	0	0	0	0	37	0	0	0	5	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	6	0	0	0	25	0	0

# of WB arrivals 1186

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	6	178	427	14	618	4	4	2	109	90	0	35
N	Y	1	182	27	0	1	0	0	0	0	9	0	2
0	N	0	4	12	0	157	296	0	0	17	28	4	4
0	Y	0	2	0	0	1	2	0	0	0	8	0	39
1	N	0	0	0	0	0	53	0	0	0	0	0	0
1	Y	0	0	0	0	0	235	0	0	0	32	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	77	0	0	0	182	0	0

Appendix A-1
Locomotive Model, Tier, and Auto-Start/Stop Technology Frequency by Train Type

# of WB departures				1186									
Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	5	177	397	13	592	4	4	1	93	83	0	33
N	Y	0	179	27	0	1	0	0	0	0	8	0	1
0	N	0	4	11	0	150	276	0	0	13	19	3	4
0	Y	0	2	0	0	1	2	0	0	0	6	0	38
1	N	0	0	0	0	0	50	0	0	0	0	0	0
1	Y	0	0	0	0	0	224	0	0	0	24	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	77	0	0	0	179	0	0

Locals

# of EB arrivals				1									
Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	0	0	0	2	0	0	0	0	0	0	0
N	Y	0	0	0	0	0	0	0	0	0	0	0	0
0	N	0	0	0	0	0	0	0	0	0	0	0	0
0	Y	0	0	0	0	0	0	0	0	0	0	0	0
1	N	0	0	0	0	0	0	0	0	0	0	0	0
1	Y	0	0	0	0	0	0	0	0	0	0	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	0	0	0	0	0	0	0

# of EB departures		Trntyp	=	8									
Tier	AESS/ZTR[1]			13									
N	N	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	Y	0	0	10	0	21	0	0	0	0	0	0	0
0	N	0	0	0	0	0	0	0	0	0	0	0	0
0	Y	0	0	1	0	2	0	0	0	0	0	0	0
1	N	0	0	0	0	0	0	0	0	0	0	0	0
1	Y	0	0	0	0	0	0	0	0	0	0	0	0
2	N	0	0	0	0	0	0	0	0	0	3	0	0
2	Y	0	0	0	0	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	0	0	0	0

Appendix A-1
Locomotive Model, Tier, and Auto-Start/Stop Technology Frequency by Train Type

Power Moves Through

# of EB arrivals 107

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	1	73	1	33	0	1	0	11	8	0	4
N	Y	0	0	2	0	0	0	0	0	0	0	0	0
0	N	0	0	0	0	5	36	0	0	1	14	1	0
0	Y	0	0	0	0	0	0	0	0	0	4	0	0
1	N	0	0	0	0	0	7	0	0	0	2	0	0
1	Y	0	0	0	0	0	19	0	0	0	13	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	3	0	0	0	6	0	0

# of EB departures 107

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	1	74	1	31	0	1	0	13	9	0	5
N	Y	0	0	2	0	0	0	0	0	0	0	0	0
0	N	0	0	0	0	4	36	0	0	1	14	1	0
0	Y	0	0	0	0	0	0	0	0	0	4	0	0
1	N	0	0	0	0	0	7	0	0	0	2	0	0
1	Y	0	0	0	0	0	18	0	0	0	13	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	3	0	0	0	9	0	0

# of WB arrivals 186

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	0	160	1	31	0	3	0	8	10	0	14
N	Y	0	2	0	0	0	0	0	0	0	0	0	0
0	N	0	0	1	0	6	33	0	0	3	7	0	0
0	Y	0	0	0	0	1	1	0	0	0	2	0	0
1	N	0	0	0	0	0	5	0	0	0	0	0	0
1	Y	0	0	0	0	0	30	0	0	0	4	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	8	0	0	0	11	0	0

Appendix A-1
Locomotive Model, Tier, and Auto-Start/Stop Technology Frequency by Train Type

# of WB departures 186

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	0	0	159	1	31	0	2	0	7	10	0	14
N	Y	0	2	0	0	0	0	0	0	0	0	0	0
0	N	0	0	1	0	6	32	0	0	3	7	0	0
0	Y	0	0	0	0	1	1	0	0	0	2	0	0
1	N	0	0	0	0	0	5	0	0	0	0	0	0
1	Y	0	0	0	0	0	29	0	0	0	4	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	8	0	0	0	11	0	0

Power Moves Arriving
# of EB arrivals 882

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	2	10	206	21	153	25	7	2	264	294	2	33
N	Y	3	1	3	0	2	0	0	0	0	20	0	1
0	N	0	0	8	0	22	724	1	0	49	55	5	1
0	Y	0	1	0	0	2	1	0	0	0	4	0	3
1	N	0	0	0	0	0	143	0	0	0	0	0	0
1	Y	0	0	0	0	0	614	0	0	0	30	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	75	0	0	0	132	0	0

# of WB arrivals 169

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	3	3	95	10	78	5	2	0	50	43	0	10
N	Y	1	7	0	0	0	0	0	0	0	4	0	0
0	N	0	0	4	0	19	99	1	0	10	21	0	0
0	Y	0	1	0	0	0	0	0	0	0	2	0	1
1	N	0	0	0	0	0	16	0	0	0	0	0	0
1	Y	0	0	0	0	0	80	0	0	0	20	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	17	0	0	0	30	0	0

Appendix A-1
Locomotive Model, Tier, and Auto-Start/Stop Technology Frequency by Train Type

Power Moves Departing

# of EB departures 146

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	7	13	103	5	157	1	7	1	23	20	0	11
N	Y	3	10	1	0	1	0	0	0	0	0	0	3
0	N	0	1	0	0	23	33	2	0	4	23	3	0
0	Y	0	1	0	0	3	0	0	0	0	16	0	1
1	N	0	0	0	0	0	5	0	0	0	2	0	0
1	Y	0	0	0	0	0	30	0	0	0	39	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	4	0	0	0	18	0	0

# of WB departures 121

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A	Unknown
N	N	2	7	73	1	103	2	1	0	23	25	0	16
N	Y	2	7	0	0	0	0	0	0	0	3	0	0
0	N	0	1	1	0	24	49	0	0	4	5	0	0
0	Y	0	0	0	0	0	0	0	0	0	1	0	3
1	N	0	0	0	0	0	6	0	0	0	0	0	0
1	Y	0	0	0	0	0	22	0	0	0	6	0	0
2	N	0	0	0	0	0	0	0	0	0	0	0	0
2	Y	0	0	0	0	0	5	0	0	0	11	0	0

Notes:

1. There are two primary types of auto start/stop technology – "Auto Engine Start Stop" (AESS), which is factory-installed on recent model high horsepower units; and the ZTR "SmartStart" system (ZTR), which is a retrofit option for other locomotives. Both are programmed to turn off the Diesel engine after 15 to30 minutes of idling, provided that various criteria (air pressure, battery charge, and others) are met. The engine automatically restarts if required by one of the monitored parameters. We assume that an AESS/ZTR-equipped locomotive will shut down after 30 minutes of idling in an extended idle event.

APPENDIX A-2

LOCOMOTIVE MODEL DISTRIBUTION
BY TRAIN TYPE GROUPS

Appendix A2
Locomotive Model Distribution by Train Type Groups

Through Trains and Through Power Moves

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.000	0.000	0.208	0.008	0.043	0.004	0.002	0.000	0.074	0.064	0.001
N	Y	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.004	0.000
0	N	0.000	0.000	0.002	0.000	0.009	0.194	0.000	0.000	0.012	0.026	0.001
0	Y	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.004	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.036	0.000	0.000	0.000	0.000	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.152	0.000	0.000	0.000	0.011	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.042	0.000	0.000	0.000	0.100	0.000
Total		0.000	0.001	0.210	0.008	0.053	0.429	0.003	0.000	0.085	0.209	0.002

Intermodal Arrivals

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.000	0.000	0.058	0.006	0.044	0.003	0.001	0.000	0.082	0.075	0.000
N	Y	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.006	0.000
0	N	0.000	0.000	0.002	0.000	0.009	0.235	0.001	0.000	0.014	0.032	0.002
0	Y	0.000	0.000	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.003	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.048	0.000	0.000	0.000	0.000	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.185	0.000	0.000	0.000	0.006	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.044	0.000	0.000	0.000	0.142	0.000
Total		0.000	0.000	0.060	0.006	0.052	0.517	0.002	0.000	0.096	0.264	0.002

Intermodal Departures

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.000	0.001	0.082	0.009	0.047	0.004	0.006	0.000	0.100	0.085	0.000
N	Y	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000
0	N	0.000	0.000	0.003	0.000	0.009	0.207	0.001	0.000	0.018	0.030	0.003
0	Y	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.003	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.043	0.000	0.000	0.000	0.000	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.170	0.000	0.000	0.000	0.013	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.039	0.000	0.000	0.000	0.117	0.000
Total		0.000	0.002	0.085	0.010	0.056	0.464	0.007	0.000	0.118	0.255	0.003

Appendix A2
Locomotive Model Distribution by Train Type Groups

Other Trains

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.018	0.052	0.152	0.004	0.291	0.001	0.003	0.001	0.029	0.030	0.000
N	Y	0.010	0.057	0.007	0.000	0.001	0.000	0.000	0.000	0.000	0.003	0.000
0	N	0.000	0.001	0.005	0.000	0.073	0.082	0.001	0.000	0.004	0.010	0.001
0	Y	0.000	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.003	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.016	0.000	0.000	0.000	0.000	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.067	0.000	0.000	0.000	0.011	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.021	0.000	0.000	0.000	0.051	0.000
Total		0.027	0.110	0.163	0.004	0.365	0.187	0.004	0.001	0.033	0.106	0.001

Power Moves Arriving

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.001	0.004	0.086	0.009	0.066	0.009	0.003	0.001	0.090	0.096	0.001
N	Y	0.001	0.002	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.007	0.000
0	N	0.000	0.000	0.003	0.000	0.012	0.235	0.001	0.000	0.017	0.022	0.001
0	Y	0.000	0.001	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.002	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.045	0.000	0.000	0.000	0.000	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.198	0.000	0.000	0.000	0.014	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.026	0.000	0.000	0.000	0.046	0.000
Total		0.003	0.007	0.090	0.009	0.079	0.514	0.003	0.001	0.107	0.187	0.002

Power Moves Departing

Tier	AESS/ZTR[1]	Switch	GP3x	GP4x	GP50	GP60	SD7x	SD90	Dash7	Dash8	Dash9	C60A
N	N	0.010	0.021	0.187	0.006	0.276	0.003	0.008	0.001	0.049	0.048	0.000
N	Y	0.005	0.018	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.003	0.000
0	N	0.000	0.002	0.001	0.000	0.050	0.087	0.002	0.000	0.008	0.030	0.003
0	Y	0.000	0.001	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.018	0.000
1	N	0.000	0.000	0.000	0.000	0.000	0.012	0.000	0.000	0.000	0.002	0.000
1	Y	0.000	0.000	0.000	0.000	0.000	0.055	0.000	0.000	0.000	0.048	0.000
2	N	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	Y	0.000	0.000	0.000	0.000	0.000	0.010	0.000	0.000	0.000	0.031	0.000

Appendix A2
Locomotive Model Distribution by Train Type Groups

Total	0.015	0.042	0.189	0.006	0.330	0.166	0.011	0.001	0.057	0.179	0.003

Appendix A2
Locomotive Model Distribution by Train Type Groups

Notes:

1. There are two primary types of auto start/stop technology – "Auto Engine Start Stop" (AESS), which is factory-installed on recent model high horsepower units; and the ZTR "SmartStart" system (ZTR), which is a retrofit option for other locomotives. Both are programmed to turn off the Diesel engine after 15 to30 minutes of idling, provided that various criteria (air pressure, battery charge, and others) are met. The engine automatically restarts if required by one of the monitored parameters. We assume that an AESS/ZTR-equipped locomotive will shut down after 30 minutes of idling in an extended idle event.

APPENDIX A-3

SAMPLE CALCULATIONS

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Appendix A-3
Sample Calculations

Activity Types

Description	Activity Code	Number of Events/Year	Locomotives per Consist	Emission Factor Group	Locomotives per Consist Working	Fraction of Calif. Fuel
Thru EB Arriving	1	3446	2.81	1	2.81	0.50
Thru EB Departing	2	3446	2.809	1	2.809	0.50
Thru WB Arriving	3	2190	2.347	1	2.347	0.50
Thru WB Departing	4	2190	2.347	1	2.347	0.50
IM EB Arrivals	5	61	1.934	2	1.934	0.00
IM WB Arrivals	6	1205	3.041	2	3.041	0.00
IM EB Departures	7	1231	3.635	3	3.635	0.90
IM WB Departures	8	106	2.066	3	2.066	0.90
Other EB Arrivals	9	11	1.727	4	1.727	0.00
Other WB Arrivals	10	49	3.49	4	3.49	0.00
Other EB Departures	11	13	2	4	2	0.90
Other WB Departures	12	3	1.667	4	1.667	0.90
Other EB Arriving and Departing Arrivals	13	565	2.503	4	2.503	0.50
Other EB Arriving and Departing Departures	14	565	2.527	4	2.527	0.50
Other WB Arriving and Departing Arrivals	15	1186	2.413	4	2.413	0.50
Other WB Arriving and Departing Departures	16	1186	2.277	4	2.277	0.50
Local EB Arrivals	17	1	2	4	2	1.00
Local EB Departures	18	13	2.846	4	2.846	1.00
Power Moves Thru EB Arriving	19	107	2.29	1	1.5	0.50
Power Moves Thru EB Departing	20	107	2.327	1	1.5	0.50
Power Moves Thru WB Arriving	21	186	1.833	1	1.5	0.50
Power Moves Thru WB Departing	22	186	1.806	1	1.5	0.50
Power Moves EB Arrivals	23	882	3.31	5	1.5	0.00
Power Moves WB Arrivals	24	169	3.74	5	1.5	0.00
Power Moves EB Departures	25	146	3.932	6	1.5	0.90
Power Moves WB Departures	26	658	3.331	6	1.5	0.90
Yard Operations - West End GP-60	27	365	1	7	1	1.00
Yard Operations - East End SD-40s	28	365	2	8	2	1.00

Appendix A-3
Sample Calculations

Emission Factors Weighted by Model/Tier/ZTR Fractions - DPM g/hr per Locomotive

Consist Groups	Group ID	Idle-NonZTR	Idle-All	DB	N1	N2	N3	N4	N5	N6	N7	N8
California Fuel (221 ppm S)												
Thru Trains and Power Moves	1	23.00	31.04	56.85	46.96	104.95	222.45	276.35	348.71	537.89	622.79	724.91
Arriving IM Trains	2	17.58	26.95	50.55	49.17	98.94	224.07	286.54	360.90	547.32	629.51	716.81
Departing IM Trains	3	20.01	28.62	55.76	49.90	101.54	224.01	282.87	356.29	533.49	611.36	707.63
Other Trains	4	30.36	37.06	69.33	43.73	112.64	226.46	259.61	326.86	521.99	628.75	766.19
Power Moves Arriving	5	21.29	29.63	54.45	47.21	95.93	219.81	279.38	354.18	556.47	642.87	742.57
Power Moves Departing	6	32.13	37.08	72.93	46.83	115.36	229.74	266.02	341.47	520.31	610.85	750.00
Yard GP-60	7	48.60	48.60	98.45	48.72	131.70	266.33	264.80	323.51	571.58	680.19	859.76
Yard SD-40s	8	47.94	47.94	80.04	35.70	134.30	211.93	228.61	289.68	488.55	584.17	749.94
47-State Fuel (2639 ppm S)												
Thru Trains and Power Moves	1	23.00	31.04	56.85	46.96	104.95	241.88	307.05	393.06	602.64	698.22	817.25
Arriving IM Trains	2	17.58	26.95	50.55	49.17	98.94	244.99	318.23	406.02	614.00	710.95	815.34
Departing IM Trains	3	20.01	28.62	55.76	49.90	101.54	245.15	314.13	400.66	598.79	692.25	807.21
Other Trains	4	30.36	37.06	69.33	43.73	112.64	242.88	288.79	370.37	582.82	691.60	845.13
Power Moves Arriving	5	21.29	29.63	54.45	47.21	95.93	238.86	310.46	399.45	623.27	719.44	837.05
Power Moves Departing	6	32.13	37.08	72.93	46.83	115.36	248.32	295.69	385.38	582.56	681.18	839.17
Yard GP-60	7	48.60	48.60	98.45	48.72	131.70	282.13	294.92	368.55	636.05	735.37	930.99
Yard SD-40s	8	47.94	47.94	80.04	35.70	134.30	224.50	254.62	330.01	543.65	631.56	812.06

Note: Idle-NonZTR is the average per-locomotive idle emission rate for the fraction of locomotives not equipped with ZTR/Auto start-stop technology

Locomotive Model Distributions
Thru Trains and Power Moves

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0004	0.2080	0.0079	0.0430	0.0037	0.0023	0.0005	0.0738	0.0635	0.0005
Pre Tier 0	Yes	0.0000	0.0003	0.0001	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0040	0.0000
Tier 0	No	0.0000	0.0000	0.0021	0.0002	0.0092	0.1941	0.0004	0.0000	0.0117	0.0260	0.0013
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0005	0.0008	0.0000	0.0000	0.0000	0.0045	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0362	0.0000	0.0000	0.0000	0.0002	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.1521	0.0000	0.0000	0.0000	0.0114	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0419	0.0000	0.0000	0.0000	0.0995	0.0000

Arriving IM Trains

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0003	0.0580	0.0061	0.0437	0.0032	0.0013	0.0000	0.0817	0.0751	0.0000
Pre Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0059	0.0000
Tier 0	No	0.0000	0.0000	0.0016	0.0003	0.0085	0.2345	0.0011	0.0000	0.0141	0.0317	0.0019
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0003	0.0024	0.0000	0.0000	0.0000	0.0029	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0479	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.1853	0.0000	0.0000	0.0000	0.0064	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0439	0.0000	0.0000	0.0000	0.1421	0.0000

Departing IM Trains

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0009	0.0818	0.0095	0.0467	0.0043	0.0060	0.0000	0.1001	0.0850	0.0000
Pre Tier 0	Yes	0.0000	0.0002	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0071	0.0000
Tier 0	No	0.0000	0.0002	0.0034	0.0002	0.0090	0.2069	0.0013	0.0000	0.0177	0.0297	0.0028
Tier 0	Yes	0.0000	0.0004	0.0000	0.0000	0.0002	0.0011	0.0000	0.0000	0.0000	0.0030	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0435	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.1696	0.0000	0.0000	0.0000	0.0127	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0390	0.0000	0.0000	0.0000	0.1173	0.0000

Other Trains

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0177	0.0515	0.1518	0.0036	0.2910	0.0012	0.0033	0.0006	0.0287	0.0296	0.0000
Pre Tier 0	Yes	0.0098	0.0567	0.0067	0.0000	0.0007	0.0000	0.0000	0.0000	0.0000	0.0027	0.0000
Tier 0	No	0.0000	0.0010	0.0047	0.0000	0.0727	0.0816	0.0005	0.0000	0.0040	0.0095	0.0014
Tier 0	Yes	0.0000	0.0005	0.0000	0.0000	0.0003	0.0005	0.0000	0.0000	0.0000	0.0026	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0157	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0669	0.0000	0.0000	0.0000	0.0108	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0207	0.0000	0.0000	0.0000	0.0511	0.0000

Power Moves Arriving

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0014	0.0037	0.0860	0.0089	0.0660	0.0086	0.0026	0.0006	0.0897	0.0962	0.0006
Pre Tier 0	Yes	0.0011	0.0023	0.0009	0.0000	0.0006	0.0000	0.0000	0.0000	0.0000	0.0069	0.0000
Tier 0	No	0.0000	0.0000	0.0034	0.0000	0.0117	0.2350	0.0006	0.0000	0.0169	0.0217	0.0014
Tier 0	Yes	0.0000	0.0006	0.0000	0.0000	0.0006	0.0003	0.0000	0.0000	0.0000	0.0017	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0454	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.1982	0.0000	0.0000	0.0000	0.0143	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0263	0.0000	0.0000	0.0000	0.0463	0.0000

Power Moves Departing

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0095	0.0212	0.1866	0.0064	0.2757	0.0032	0.0085	0.0011	0.0488	0.0477	0.0000
Pre Tier 0	Yes	0.0053	0.0180	0.0011	0.0000	0.0011	0.0000	0.0000	0.0000	0.0000	0.0032	0.0000
Tier 0	No	0.0000	0.0021	0.0011	0.0000	0.0498	0.0870	0.0021	0.0000	0.0085	0.0297	0.0032
Tier 0	Yes	0.0000	0.0011	0.0000	0.0000	0.0032	0.0000	0.0000	0.0000	0.0000	0.0180	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0117	0.0000	0.0000	0.0000	0.0021	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0551	0.0000	0.0000	0.0000	0.0477	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0095	0.0000	0.0000	0.0000	0.0308	0.0000

Yard GP-60

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0000	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pre Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Yard SD-40s

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pre Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 0	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Appendix A-3
Sample Calculations

Track Segment	Segment Number	Length (mi)
E End of Yard to Local	1	0.555200
Local E End Lead In	2	0.127200
E End of Yard to IM Tracks	3	0.321700
IM E End Lead In	4	0.070600
E End of Yard to Other Tracks	5	0.418700
Other Tracks E End Lead In	6	0.064000
E End of Yard to Service	7	1.093100
Main Line E End to West End	8	2.437400
IM E End to Service	9	0.777400
Other E End to Service	10	0.508000
W End of Yard to Local	11	0.217500
W End of Yard to IM	12	0.855600
IM W End Lead In	13	0.140900
W End of Yard to Other	14	0.855600
Other W End Lead In	15	0.149900
W End of Yard to Service	16	1.283300
Local West End	17	0.307500
IM West End	18	0.215500
Other West End	19	0.198200
Service to Shop	20	0.174400
Shop to House Track	21	0.130500
House Track to Ready Track	22	0.307700
Yard West Half	23	1.218700
Yard East Half	24	1.218700
West Split to Service	25	0.437100
IM West Center	26	0.323300
Other West Center	27	0.297300
Local West Center	28	0.461300
IM East Center	29	0.323300
Other East Center	30	0.297300
Local East Center	31	0.461300
IM E End	32	0.215500
Other E End	33	0.198200
Local Track E End	34	0.307500

Appendix A-3
Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment Moving
Thru EB	1 or 2	8	30	1	0	0	1
Thru WB	3 or 4	8	30	2	0	0	1
IM EB Arrivals	5	12	5	3	0	0	1
"	5	13	5	3	0	0	1
"	5	18	5	3	0	0	1
"	5	26	5	3	0	0	1
"	5	29	5	3	0	0	1
"	5	32	5	3	0.5	0.5	0
"	5	-32	5	3	0	0	1
"	5	-4	5	3	0	0	1
"	5	-9	5	3	0	0	1
IM WB Arrivals	6	3	5	3	0	0	1
"	6	4	5	3	0	0	1
"	6	32	5	3	0	0	1
"	6	29	5	3	0	0	1
"	6	26	5	3	0	0	1
"	6	18	5	3	0.5	0.5	0
"	6	-18	5	3	0	0	1
"	6	-13	5	3	0	0	1
"	6	-25	5	3	0	0	1
IM EB Departures	7	-9	5	3	0	0	1
"	7	-4	5	3	0	0	1
"	7	-32	5	3	0	0	0.2
"	7	32	5	3	1.5	0.5	0.2
"	7	4	5	3	0	0	1
"	7	3	5	3	0	0	1
IM WB Departures	8	-25	5	3	0	0	1
"	8	-13	5	3	0	0	1
"	8	-18	5	3	0	0	0.2
"	8	18	5	3	1.5	0.5	0.2
"	8	13	5	3	0	0	1
"	8	12	5	3	0	0	1
Other EB Arrivals	9	14	5	3	0	0	1
"	9	15	5	3	0	0	1
"	9	19	5	3	0	0	1
"	9	27	5	3	0	0	1
"	9	30	5	3	0	0	1
"	9	33	5	3	0.5	0.5	0
"	9	-33	5	3	0	0	1
"	9	-6	5	3	0	0	1
"	9	-10	5	3	0	0	1
Other WB Arrivals	10	5	5	3	0	0	1
"	10	6	5	3	0	0	1
"	10	33	5	3	0	0	1
"	10	30	5	3	0	0	1
"	10	27	5	3	0	0	1
"	10	19	5	3	0.5	0.5	0
"	10	-19	5	3	0	0	1

Appendix A-3
Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment Moving
"	10	-15	5	3	0	0	1
"	10	-25	5	3	0	0	1
Other EB Departures	11	-10	5	3	0	0	1
"	11	-6	5	3	0	0	1
"	11	-33	5	3	0	0	0.2
"	11	33	5	3	1.5	0.5	0.2
"	11	6	5	3	0	0	1
"	11	5	5	3	0	0	1
Other WB Departures	12	-25	5	3	0	0	1
"	12	-15	5	3	0	0	1
"	12	-19	5	3	0	0	0.2
"	12	19	5	3	1.5	0.5	0.2
"	12	15	5	3	0	0	1
"	12	14	5	3	0	0	1
Other EB Arriving and Departing Arrivals	13	14	5	3	0	0	1
"	13	15	5	3	0	0	1
"	13	19	5	3	0	0	1
"	13	27	5	3	0	0	1
"	13	30	5	3	0	0	1
"	13	33	5	3	0.5	0.5	1
Other EB Arriving and Departing Departures	14	6	5	3	0	0	1
"	14	5	5	3	0	0	1
Other WB Arriving and Departing Arrivals	15	5	5	3	0	0	1
"	15	6	5	3	0	0	1
"	15	33	5	3	0	0	1
"	15	30	5	3	0	0	1
"	15	27	5	3	0	0	1
"	15	19	5	3	0.5	0.5	1
Other WB Arriving and Departing Departure	16	15	5	3	0	0	1
"	16	14	5	3	0	0	1
Local EB Arrivals	17	11	5	3	0	0	1
"	17	17	5	3	0	0	1
"	17	28	5	3	0	0	1
"	17	31	5	3	0	0	1
"	17	34	5	3	0.5	0.5	0
"	17	-34	5	3	0	0	1
"	17	-2	5	3	0	0	1
"	17	-1	5	3	0	0	1
"	17	-7	5	3	0	0	1
Local EB Departures	18	-7	5	3	0	0	1
"	18	-1	5	3	0	0	1
"	18	-2	5	3	0	0	1
"	18	-34	5	3	0	0	0.2
"	18	34	5	3	1.5	0.5	0.2
"	18	2	5	3	0	0	1
"	18	1	5	3	0	0	1
Power Moves Thru EB	19 or20	8	30	1	0	0	1
Power Moves Thru WB	21	8	30	2	0	0	1

Appendix A-3
Sample Calculations

Movement Type	Activity Code	Segment Number	Speed (mph)	Duty Cycle Number	Non-ZTR Idle Time (hrs)	ZTR Idle Time (hrs)	Fraction of Segment Moving
Power Moves EB Arrivals	23	16	5	3	0	0	1
Power Moves WB Arrivals	24	7	5	3	0	0	1
Power Moves EB Departures	25	7	5	3	0	0	1
Power Moves WB Departures	26	16	5	3	0	0	1

Notes
(1) Segment numbers listed as negative values are in-yard power moves from arriving trains to service or from service to departing trains
(2) Non-ZTR Idling is the duration of an idle event when units without ZTR continue to idle after ZTR-equipped units have shut down
(3) Idling All is the duration of idling during which all locomotives continue to idle
(4) Fraction of Segment Moving is the fraction of the length of the segment over which the movement occurs
(On departure, power moves from service are assumed to connect to trains 20% of the way into a track segment)

Appendix A-3
Sample Calculations

Yard Operations	**Activity Code**	**Duty Cycle Number**	**Non-ZTR Idle Time (hrs)**	**ZTR Idle Time (hrs)**	**Working Time (hrs)**
West End	27	4	0	0	16
East End	28	4	0	0	16

Duty Cycles (Percent of Time by Notch)	**Duty Cycle Number**	**Idle**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Thru EB	1	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%
Thru WB	2	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
In Yard Movement	3	0.0%	0.0%	50.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Yard Operations	4	59.8%	0.0%	12.4%	12.3%	5.8%	3.6%	3.6%	1.5%	0.2%	0.8%

Appendix A-3
Sample Calculations

Emission Factors Weighted by Model/Tier/ZTR Fractions - DPM g/hr per Locomotive

Locomotive Model Group	Idle-NonZTR	Idle-All	DB	N1	N2	N3	N4	N5	N6	N7	N8
California Fuel (221 ppm S)											
Service	20.76	29.75	56.22	47.39	99.31	219.03	274.79	348.92	534.45	616.17	715.49
LoadTest	22.43	30.92	60.85	48.89	100.65	221.43	276.68	355.96	536.23	614.85	720.02
47-State Fuel (2639 ppm S)											
Service	20.76	29.75	56.22	47.39	99.31	238.52	305.29	393.09	599.05	692.38	809.13
LoadTest	22.43	30.92	60.85	48.89	100.65	241.52	307.36	400.74	601.41	692.93	816.63

Note: Idle-NonZTR is the average per-locomotive idle emission rate for the fraction of locomotives not equipped with ZTR/Auto start-stop technology

Service and Shop Activity

			Duration of Activity per Locomotive (minutes)										
Activity	**Number of Locomotives**	**Fraction of Calif. Fuel**	**Idle-NonZTR**	**Idle-All**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Service - Inbound and Service	9467	0.00	90	30	0	0	0	0	0	0	0	0	0
Service - Post-Service	9467	0.90	90	30	0	0	0	0	0	0	0	0	0
Shop - Inbound and Outbound	4101	0.90	60	60	0	0	0	0	0	0	0	0	0
Pre-Maintenance Load Test	427	0.90	0	2	0	0	0	0	0	0	0	0	8
Post-Maintenance Load Test	427	0.90	0	10	0	10	0	0	0	0	0	0	10
Quarterly Maintenance Load Tes	402	0.90	0	2	0	0	0	0	0	0	0	0	8
Unscheduled Mtc Diagnostic Tes	35	0.90	0	5	0	0	0	0	0	0	0	0	10
Unscheduled Mtc Post Test	1061	0.90	0	10	0	10	0	0	0	0	0	0	10

Appendix A-3
Sample Calculations

Locomotive Model Distributions

Locomotives Serviced

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0176	0.0056	0.0903	0.0083	0.0636	0.0049	0.0041	0.0001	0.0855	0.0764	0.0000
Pre Tier 0	Yes	0.0078	0.0068	0.0004	0.0000	0.0004	0.0000	0.0000	0.0000	0.0000	0.0057	0.0000
Tier 0	No	0.0015	0.0011	0.0047	0.0001	0.0137	0.2048	0.0012	0.0000	0.0181	0.0305	0.0025
Tier 0	Yes	0.0050	0.0049	0.0001	0.0000	0.0004	0.0011	0.0000	0.0000	0.0000	0.0042	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0272	0.0000	0.0000	0.0000	0.0003	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.1804	0.0000	0.0000	0.0000	0.0136	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0011	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0301	0.0000	0.0000	0.0000	0.0761	0.0000

Locomotives Load Tested

Technology	ZTR/AESS	Switcher	GP-3x	GP-4x	SD-50	GP-60	SD-7x	SD-90	Dash 7	Dash 8	Dash 9	C-60
Pre Tier 0	No	0.0000	0.0067	0.1025	0.0107	0.0583	0.0013	0.0107	0.0000	0.1112	0.0717	0.0000
Pre Tier 0	Yes	0.0000	0.0121	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0054	0.0000
Tier 0	No	0.0000	0.0013	0.0060	0.0000	0.0174	0.1949	0.0020	0.0000	0.0234	0.0422	0.0054
Tier 0	Yes	0.0000	0.0054	0.0000	0.0000	0.0007	0.0020	0.0000	0.0000	0.0000	0.0067	0.0000
Tier 1	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0221	0.0000	0.0000	0.0000	0.0000	0.0000
Tier 1	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.1882	0.0000	0.0000	0.0000	0.0268	0.0000
Tier 2	No	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0027	0.0000
Tier 2	Yes	0.0000	0.0000	0.0000	0.0000	0.0000	0.0201	0.0000	0.0000	0.0000	0.0422	0.0000

Appendix A-3
Sample Calculations

Example 1 -- WB Arriving Intermodal Train

Parameter	**Value**
Activity Code	6
Number of Events	1205
Locomotives per Consist on Train	3.041
Locomotives per Consist Working During Power Moves	1.5
Emission Factor Group	2
Fraction of Calif. Fuel	0.00

Route Followed	**Segment Number**	**Length (miles)**	**Speed (mph)**	**Power Move**	**Non-ZTR Idle (hrs)**	**ZTR Idle (hrs)**	**Locomotive Hours Moving**	**Locomotive Hours NonZTR Idle**	**Locomotive Hours ZTR Idle**
E End of Yard to IM Tracks	3	0.322	5	N	0	0	235.77	0.00	0.00
IM E End Lead In	4	0.071	5	N	0	0	51.74	0.00	0.00
IM E End	32	0.216	5	N	0	0	157.94	0.00	0.00
IM East Center	29	0.323	5	N	0	0	236.94	0.00	0.00
IM West Center	26	0.323	5	N	0	0	236.94	0.00	0.00
IM West End	18	0.216	--	N	0.5	0.5	0.00	1832.20	1832.20
IM West End	18	0.216	5	Y	0	0	77.90	0.00	0.00
IM W End Lead In	13	0.141	5	Y	0	0	50.94	0.00	0.00
West Split to Service	25	0.437	5	Y	0	0	158.01	0.00	0.00
Total							*1206.18*	*1832.20*	*1832.20*

Emission Factors	**Group ID**	**Idle-NonZTR**	**Idle-All**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Arriving IM Trains - CA Fuel	2	17.58	26.95	50.55	49.17	98.94	224.07	286.54	360.9	547.32	629.51	716.81
Arriving IM Trains - 47-State Fuel	2	17.58	26.95	50.55	49.17	98.94	244.99	318.23	406.02	614	710.95	815.34
CA Fuel Fraction Adjusted Rates		*17.58*	*26.95*	*50.55*	*49.17*	*98.94*	*244.99*	*318.23*	*406.02*	*614*	*710.95*	*815.34*
Duty Cycle Moving		0%	0%	0%	50%	50%	0%	0%	0%	0%	0%	0%
Weighted g/hr emissions		0	0	0	24.585	49.47	0	0	0	0	0	0

Appendix A-3
Sample Calculations

	Moving	Idle-NonZTR	Idle-All
Emission Rate (g/hr)	74.06	17.58	26.95
Locomotive Hours	1206.18	1832.20	1832.20
Total Emissions (g/yr)	**89323**	**32210**	**49378**

Example 2 -- Quarterly Maintenance Load Testing

Number of Quarterly Maintenance Load Tests	402
Fraction of Calif. Fuel	0.90

Emission Factors (g/hr)	**Group ID**	**Idle-NonZTR**	**Idle-All**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Load Tested Locomotives CA Fuel	LoadTest	22.43	30.92	60.85	48.89	100.65	221.43	276.68	355.96	536.23	614.85	720.02
Load Tested Locomotives 47-State Fuel	LoadTest	22.43	30.92	60.85	48.89	100.65	241.52	307.36	400.74	601.41	692.93	816.63
CA Fuel Fraction Adjusted Rates		*22.43*	*30.92*	*60.85*	*48.89*	*100.65*	*223.44*	*279.75*	*360.44*	*542.75*	*622.66*	*729.68*

		Duration (minutes)										
Activity	**Number of Locomotives**	**Idle-NonZTR**	**Idle-All**	**DB**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
Quarterly Maintenance Load Test	402	0	2	0	0	0	0	0	0	0	0	8

Emissions (g)												
Notch-Specific		0.0	414.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39110.9

Total Emissions (g/yr)	**39525**

APPENDIX A-4

METHODOLOGY FOR ESTIMATING LOCOMOTIVE EMISSIONS AND GENERATING AERMOD EMISSION INPUTS

Appendix A-4

Methodology for Estimating Locomotive Emissions and Generating AERMOD Emission Inputs

Overview

This appendix describes the general procedures followed for developing locomotive emission inventories for the Union Pacific Railroad (UPRR) rail yards under the Memorandum of Understanding with the California Air Resources Board. It also describes the procedure by which the emission inputs for both locomotive and non-locomotive sources used in AERMOD dispersion modeling.

EMISSION CALCULATIONS

This section describes the details of the development of activity inputs, emission factors, and emission estimates for locomotive operations. Separate procedures are followed for estimating activity associated with locomotives on trains, locomotive consist movements within a yard, service and shop activity (if occurring at a specific yard), and yard switching operations within a yard. Emission factors are developed for each of the types of locomotive activity based on the model and technology distribution of locomotives involved in each activity. Emission estimates are then developed for the activities and specific areas of a yard in which each activity occurs. The data used to calculate these emissions are included in the Appendix A-3 Excel workbook, which includes a "Sample Calculations" worksheet showing the linkages between the various activities, emission factors, and operating characteristics data.

Train Activity

Train activity data for emissions calculations includes a number of separate components:

- The number of trains arriving, departing, or passing through a yard, broken down by type of train
- The average composition of working locomotives in each consist[1], including the fraction of locomotives of different models, emissions technology tier, and automatic idling control equipment[2]
- The identification of routes followed for different types of train activities

[1] The term "consist" refers to the group of locomotives (typically between one and four) that provide power for a specific train.
[2] Two types of automatic idling control equipment are in use, known as ZTR SmartStart (typically retrofit equipment on low horsepower units) and AESS (typically factory installed on newer high horsepower units). Both are programmed to automatically shut of the engines of parked idling locomotives after a specified period of time, and to restart the unit if any of a number of operating parameters (battery state, air pressure, coolant temperature, etc.) reach specified thresholds.

- Identification of the speeds and throttle settings for different types of train activities in different locations.

The primary source of information for estimating train activity is a database identifying the arrival and departure of locomotives at a specific yard. This database identifies locomotives by their ID numbers and models, the status on the train (working or not working), and the specific train to which they are connected. From these data, the total numbers of trains of different types are identified based on train symbols, train dates, train origination and termination indicators, and dates and times of arrival and departure. For each type of train and activity, the average number of locomotives per consist is calculated along with the distribution of locomotive models, emission technology tiers, and automatic idling control equipment. A separate database of UPRR locomotives is consulted based on locomotive ID to determine the tier and date of any retrofits of automatic idling controls to complete the development of these model distributions. The activity data so derived are shown on the “Activities” worksheet in the Appendix A-3 Excel workbook, and the model and technology distributions are shown on the “Consist Emissions” worksheet.

The types of trains to be identified can vary from yard to yard. For all yards, through trains (which bypass the yard itself on mainline tracks adjacent to the yard) are identified. Depending on the yard, trains entering or departing from the yard can be of several types, including:

- Intermodal trains
- Automobile trains
- “Manifest” or freight trains
- Local trains
- Power moves

Power moves are trains consisting only of locomotives which are either arriving at the yard to be serviced or used for departing trains, or departing from the yard to be serviced at another location or used for trains departing from another location. The routes followed by each type of train on arrival and departure are identified in consultation with UPRR yard personnel, along with estimates of average speeds and duty cycles (fraction of time spent at different throttle settings) for different areas.

Specific track subsections are identified by UTM coordinates digitized from georeferenced aerial photographs. The segments identified and their lengths are shown on the “Track Segments” worksheet of Appendix A-3. For each train type, direction, and route, a listing of track segments, segment lengths, and duty cycles is developed. Duty cycles are shown on the “Consist Emissions” worksheet of Appendix A-3, and the segment speeds, duty cycles, idling durations are shown on the “Movements and Yard Operations” worksheet. This listing, along with the number of locomotives per consist and number of trains of each type, allows calculation of the number of locomotive hours in each duty cycle to be calculated for each section of track. For arriving and departing trains, estimates of the duration of idling were developed in consultation with UPRR personnel. These idling periods were divided into two parts – the assumed amount of time that all locomotives in a consist would idle on arrival or departure, and the amount of time that only locomotives not equipped with automatic idle controls would idle. Idling periods were assigned to a segment of the arrival or departure track one fifth of the length of the track at the appropriate end.

Service and Shop Activity

If there is a service track and/or shop at a yard, locomotives (including both road power from trains as well as yard switchers) undergo a variety of activities at these locations. If present at a yard, details of the service and shop activity, model distributions, and emission factors are shown on the "Service and Shop" worksheet of Appendix A-3. Specific locomotive activities involve idling while awaiting or undergoing routine service (cleaning, refueling, oiling, sanding, and other minor maintenance), movement and idling between service and maintenance areas, and stationary load testing associated with specific types of maintenance events. A database of service events at individual yards identifies the number of service events during the year, the locomotive ID and model, and the nature of servicing performed. Routine servicing involves periods of idling prior to and during service, and additional idling prior to movement of consists to departing trains in the yard. Estimates of the duration of idling associated with servicing are developed in consultation with UPRR personnel. As was done for trains, these idling periods were separated into two parts, the average total duration of idling by all locomotives, and the average duration of additional idling by locomotives not equipped with automatic idling controls.

The database also specifically identifies load test events and the type of maintenance with which the load testing is associated. These types include planned maintenance at different intervals (e.g., quarterly, semiannual) as well as unscheduled maintenance which may involve both diagnostic load testing prior to maintenance and post-maintenance load testing. The duration of load test events in each throttle setting depend on the equipment available and types of maintenance performed at the yard. Estimates of these durations, as well as the identification of load testing activity by type of load test and the time and duration of any additional idling and movements are developed in consultation with UPRR personnel.

A total number of events (servicing and load testing by location and type) are developed from these data, as are locomotive model and technology distributions for all locomotives serviced and for those specific locomotives undergoing load testing (if applicable). From these event counts and durations, the total number of hours of locomotive idling and higher throttle setting operation in different portions of the service areas are calculated for each of the two model distributions.

Yard Switcher Activity

In each yard, there are routine jobs assigned to individual switchers or sets of switchers. These activities are generally not tracked from hour to hour, but they occur routinely within yard boundaries during specified work shifts. Similarly, the specific yard switcher locomotive IDs assigned to these jobs are not routinely tracked, but these yard jobs are generally assigned to a specific model of low horsepower locomotive. From the assigned yard switcher jobs and shifts, and in consultation with UPRR personnel, an estimate of the hours per day of switcher operation in a yard are developed, along with the specific times of day when these activities occur (time of day assignments were made only if operation was less than 24 hour per day). Duty cycles for switching operation are also developed in consultation with local UPRR personnel. Depending on the type of activity and type of trains being handled in a yard, duty cycle estimates may vary. In the absence of more detailed information, the USEPA switcher duty cycle is assumed to be representative of each switcher's operation[3]. The total number of locomotive hours of operation for each model are calculated and assigned to the areas in which the units work. In some cases, yard jobs are assigned to specific areas within the yard and specific models of locomotives. In these cases, the switcher activities are assigned specifically to these areas of the yard.

Emission Factor Development

The locomotive model and technology group distributions derived in the development of activity data are grouped by type or types of activity with consideration for the level and nature of the activity. For example, a single distribution is used for through trains of all types, including power moves, while consist model distributions for different types of trains within a yard may be treated as separate distributions if they are handled in different areas of a yard. As shown in Part VII of this report model-group-specific emission factors by throttle setting were developed based on emission test data and sulfur content adjustment factors. From these emission factors and the locomotive model and technology distributions for different types of trains and activities, weighted average emission factors are calculated for the "average" locomotive for that train type or activity on a gram per hour basis. For each train type or activity, two separate idle emission rates are calculated. The first is the straight weighted average emission rate for all locomotives, while the second is the weighted average only for the fraction of locomotives without automatic idle controls. Mathematically,

$$\overline{Q}(l) = \sum_{i=1}^{11} \sum_{j=1}^{4} \sum_{k=1}^{2} F(i,j,k) \cdot Q(i,j,l)$$

for l corresponding to idle through N8, and

$$\overline{Q}(l^*) = \sum_{i=1}^{11} \sum_{j=1}^{4} F(i,j,1) \cdot Q(i,j,l^*)$$

for idling emission rate during periods when only locomotives without automatic idle controls are idling

where

[3] USEPA (1998). Locomotive Emission Standards -- Regulatory Support Document. (Available at *www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf*).

$\overline{\overline{Q}}(l)$ = weighted average emission factor for throttle setting l

$Q(i,j,l)$ = the base g/hr emission factor of a particular model group/technology class and throttle setting

$F(i,j,k)$ = the fraction of locomotives of a particular model group/technology class

i = model group index (Switcher, GP-3x, etc.)

j = technology tier index (pre-Tier 0, Tier 0, Tier 1, Tier 2)

k = automatic idle control status index (with or without)

l = throttle setting (idle, N1, . . ., N8)

l^* = index for idle throttle of locomotives without automatic idle controls.

Thus, for each defined locomotive model distribution, gram per hour emission factors are generated for each throttle setting.

Emission Calculations – Locomotive Movements

From the train activity analysis, the following data are available for each segment of track: track length of segment $L(i)$; speed $V(i)$; movement duty cycle $\boldsymbol{D}(i)$ (a vector of fractions of time spent in each throttle setting); number of trains of each type $N(j)$; and number of working locomotives per consist for each train type $C(j)$. For each type of train j, there is a set of throttle-specific emission factors $Q_j(l)$ for the "average" locomotive used on that train type. If a particular type of train or consist movement can follow multiple paths within the yard, the activity is allocated to sequences of track segments representing each such path. Total annual emissions $q_{tot}(i)$ for each segment are then calculated as

$$q_{tot}(i) = \frac{L(i)}{V(i)} \cdot \sum_j N(j) \cdot C(j) \sum_l D(i,l) \cdot Q_j(l) .$$

Emission Calculations – Locomotive Idling

Locomotive idling is calculated in a similar manner for road power and locomotives in service. For each train type and for service events, activity data provide a number of annual events $N(i)$, duration of idling by locomotives with ($T_{all}(i)$) and without ($T_{nZTR}(i)$)automatic idle control, and gram per hour emission rates for the "average" locomotive $Q_{all}(i)$, and the "average" locomotive excluding those with automatic idle controls $Q_{nZTR}(i)$. Total annual emissions are calculated as

$$q_{idle} = \sum_i N(i) \cdot C(i) \cdot (T_{all}(i) \cdot Q_{all}(i) + T_{nZTR}(i) \cdot Q_{nZTR}(i)) .$$

If a particular type of activity occurs at multiple locations within the yard (e.g., on multiple arrival or departure tracks), then the idling time is allocated to different segments of track as appropriate so that segment-specific emissions are obtained.

Emission Calculations – Load Testing

Load testing emissions are calculated separately for each throttle setting (idle, N1 and N8) using the weighted average emission factors for the load-tested units, the number of load tests of different types, and the duration of testing in each throttle setting for each type of test.

Emission Calculations – Yard Switcher Operations

Activity data provide the number and model group information for yard switchers, and the number of operating hours per day. Model-group specific emission factors are multiplied by the duty cycle to generate weighted average gram per hour emissions for idling and for combined emissions from operation in notch 1 through notch 8. Emissions are calculated directly from the number of units, hours per day working, and duty cycle weighted emission factors for both idle and non-idle throttle settings during work shifts.

AERMOD EMISSION INPUT PREPARATION

Emissions from both locomotives and from other emission sources in a yard are allocated to multiple individual point or volume sources in AERMOD inputs. In addition to each type of activity's emission rates, the locations of emissions, the release parameters, and other inputs (e.g., building downwash parameters, temporal variation in emissions, etc.) are required by AERMOD. Emission inputs are prepared sequentially for different types of activities and the areas within which they occur. The source elevation for each point or volume source is interpolated from a high resolution terrain file.

Locomotive Movements

For each type of locomotive movement, emissions calculated for each track segment are uniformly allocated to a series of evenly spaced volume sources along that track segment. The maximum spacing between sources is specified and the number of sources to be used for each segment is calculated from the segment length. The raw emission rate value in the AERMOD inputs (g/sec) is based directly on the annual emission total for the segment divided by the number of sources on that segment. For locomotive movements, separate day and night release parameters are needed. Therefore, each source is duplicated (but with a different source ID and parameters) in the AERMOD inputs, with temporal profile inputs (EMISFACT HROFDY) that use day time parameters from 0600-1800 and night time parameters for 1800-0600.

Locomotive Idling and Load Testing

Locomotive idling and load testing emissions are allocated to track segments in the same manner as locomotive movements, but as point, rather than volume sources. Each source location may have up to three separate sources identified, with different stack parameters used for idle, notch 1 and notch 8. Building downwash inputs are assigned from a pre-

prepared set of records for a typical locomotives dimensions and the orientation of the track segment on which the emissions occur.

Yard Switcher Operations

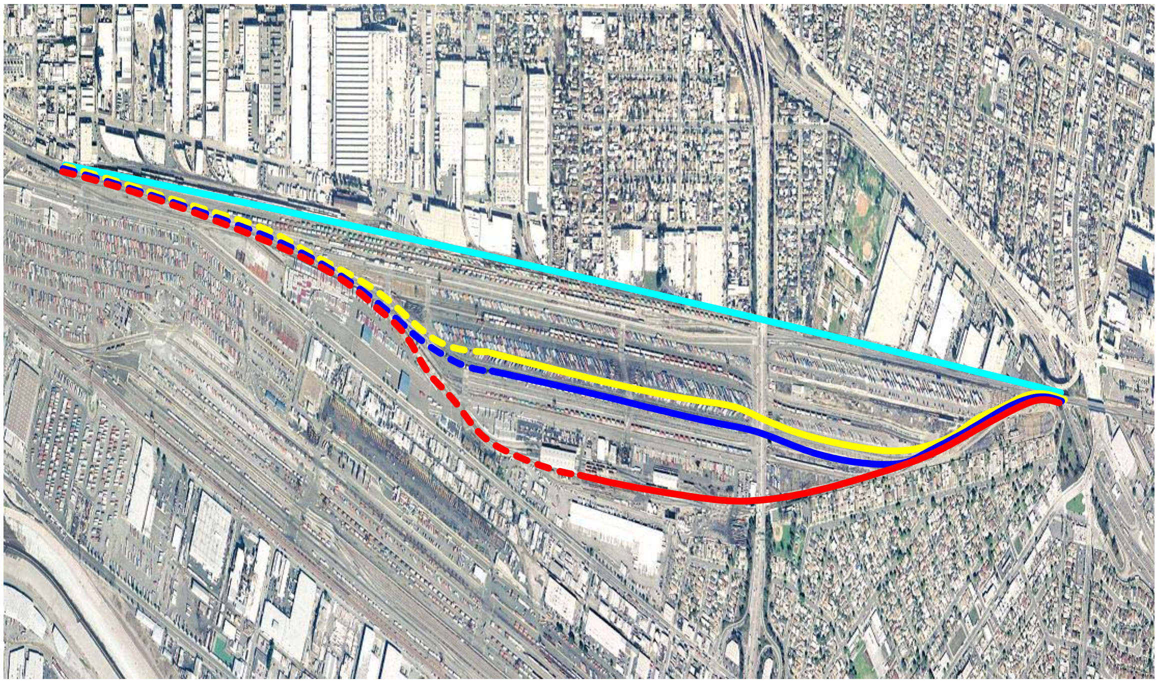
Yard switcher operations are allocated to areas within the yard based on the estimated time spent working in each area. As for locomotive movements, yard switcher emissions for a specific area are allocated uniformly to a number of volume sources on defined segments. Day and night operations are handled similarly to train and consist movements, with EMISFACT HROFDY records used to switch day and night volume source release parameters. Depending on their magnitude and distance from yard boundaries, the "working idling" emissions for yard switching may be added to the non-idle emissions from volume sources, or treated as a series of point sources, using stack parameters for the specific model group being used. If treated as point sources, building downwash inputs are prepared as for other locomotive idling and load testing.

APPENDIX A-5

PRINCIPLE LOCOMOTIVE ROUTES

Appendix A-5
Principle Locomotive Routes

Through Trains and West Bound Arrivals and Departures

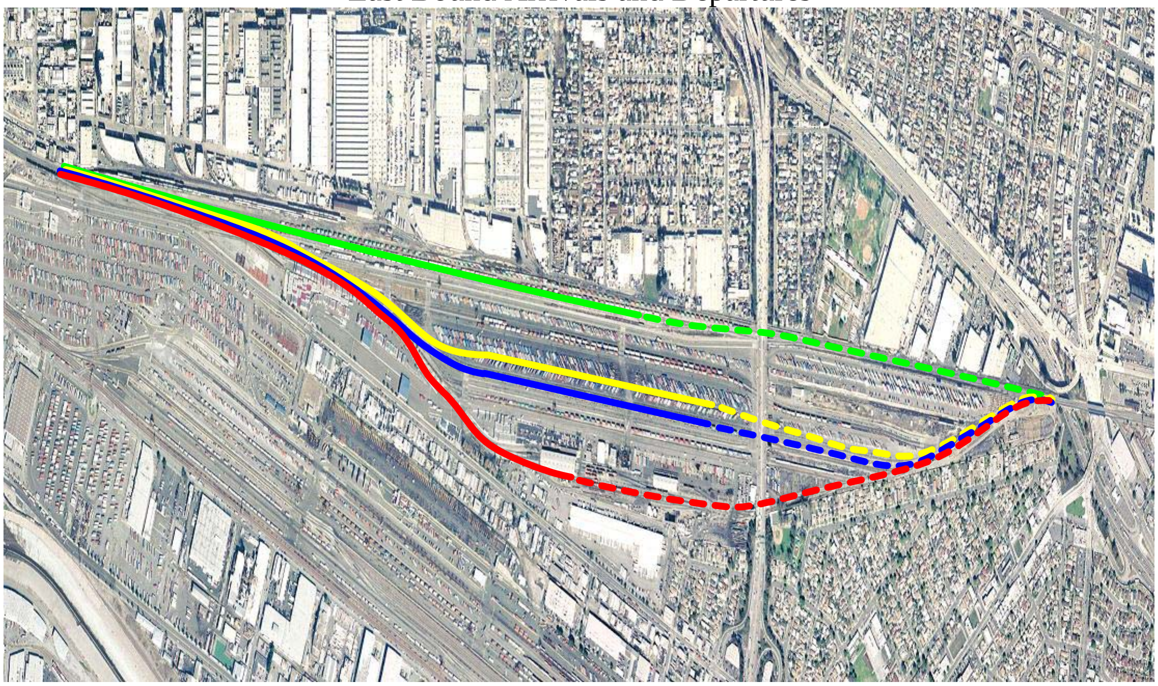


Through trains (light blue)
Intermodal trains (yellow)
Other trains (blue)
Power moves (red)
Arrivals (solid)
Departures (dashed)

Note – the horizontal scale was compressed for clarity.

Appendix A-5
Principle Locomotive Routes

East Bound Arrivals and Departures

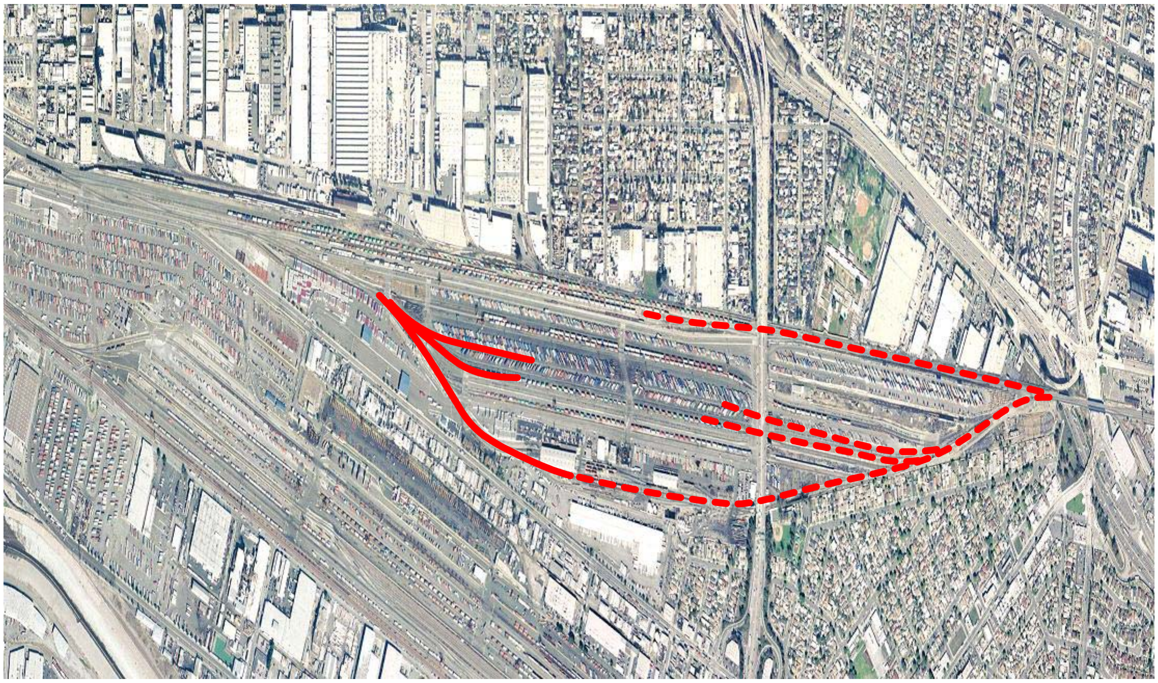


Local trains (green)
Intermodal trains (yellow)
Other trains (blue)
Power moves (red)
Arrivals (solid)
Departures (dashed)

Note – the horizontal scale was compressed for clarity.

Appendix A-5
Principle Locomotive Routes

In-Yard Power Moves to and from Service



To and from eastbound trains (dashed)
To and from westbound trains (solid)

Note – the horizontal scale was compressed for clarity.

APPENDIX A-6

IRESON ET AL

Development of Detailed Railyard Emissions to Capture Activity, Technology and Operational Changes

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ABSTRACT

Railyard operations involve a variety of complex activities, including inbound and outbound train movements, classification (i.e., separating cars from inbound trains for redirection to multiple destinations, and building new trains), and servicing locomotives. Standard locomotive duty cycles provide long-term average activity patterns for locomotive operations, but they are not appropriate for the specialized activities that occur within railyards or at locations such as ports, and emission densities in such areas can be high relative to those of line haul activities. There are significant emission rate differences between locomotive models, and differences in the types of service for which specific models are used. Data for throttle-specific emissions, activity levels, and locomotive models and operating practices can be used to provide more accurate emissions estimates for such operations. Such data are needed to quantify actual emissions changes in these high activity areas. A calculation scheme has been developed to generate detailed emission inventories based on the types of data that are collected for managing rail operations. This scheme allows improved accuracy in emissions estimation, and also provides a more reliable basis for bottom-up tracking of emissions changes over time. Factors that can be addressed include: changes in the distribution of locomotive models and control technology levels (e.g., increasing fractions of Tier 0, 1, and 2 locomotives) for both line haul and local operations; actual in-yard idling duration and reductions associated with auto-start-stop technologies; fuel quality effects; and detailed operating practices for switching and train-building operations. By providing detailed disaggregation of activity and emissions data, the method also makes it possible to quantify and evaluate the effects of specific emission reduction alternatives.

INTRODUCTION

Freight movement by rail is a key component of the U.S. transportation infrastructure. The combination of rail's low rolling resistance and the fuel-efficient turbocharged diesel engines used in modern locomotives make rail the most efficient mode of transport from both an emissions and economic perspective. Railyards located strategically through the nation's rail network are used to assemble and direct goods movement to their destinations. Railyards may handle dozens of trains per day, each powered by a "consist" of several locomotives. While in railyards, these locomotives are serviced and regrouped into new consists as needed for specific departing trains. In addition to train arrivals and departures and locomotive servicing, so-called "classification" yards separate rail cars in inbound trains into segments with different destinations, and build new trains with a common destination. This work is accomplished by switcher locomotives (typically of lower horsepower than the locomotives used for "line-haul" operations). Some railyards also have major locomotive repair facilities whose activities include load testing of locomotives prior to or after maintenance. Collectively, the locomotive operations associated with these activities can result in relatively high localized emission densities.

The Union Pacific Railroad (UPRR) is the largest railroad in North America, operating throughout the western two-thirds of the United States. It operates a number of railyards throughout its system, including the J. R. Davis Yard in Roseville, California. The Davis Yard is UPRR's largest classification yard in the western U.S. It is approximately one-quarter mile wide and four miles long, and is visited by over 40,000 locomotives per year. The California Air Resources Board (CARB) recently completed a detailed dispersion modeling study to estimate concentrations of diesel particulate matter in the vicinity of the railyard.[1] UPRR cooperated closely with CARB in this study, including the identification, retrieval and analysis of data needed to assemble a detailed emission inventory for railyard operations. This effort produced the most detailed emission inventory for railyard operations to-date, including empirically developed train counts, locomotive model distributions, locomotive service and maintenance activities, and dedicated on-site switching operations. The results of this effort have been further adapted to allow UPRR to track the effect of locomotive fleet modernization, freight volume, and operational changes on emissions, and to identify opportunities for further emission reductions at the Davis Yard.

RAILYARD ACTIVITY ESTIMATION

At state and national levels, locomotive emissions have been estimated using locomotive fleet population data and average locomotive emission factors, expressed in g/bhp-hr, in conjunction with fuel efficiency estimates and fuel consumption. For freight locomotives, the emission factors are typically derived using both a switching duty cycle and a line haul duty cycle, each of which gives the fraction of operating time locomotives spend at different throttle settings, referred to as notch positions.[2] These throttle settings (see Table 1) include idle, notches 1 through 8, and dynamic braking (in which the locomotive traction motors are used to generate power which is dissipated through resistor grids). While this approach can provide reasonable estimates for larger regions, neither the overall locomotive fleet composition nor the standard duty cycles accurately reflect the specific activities that occur within an individual railyard. The g/bhp-hr emission factors vary substantially between throttle settings and between locomotive models. Other confounding factors include: speed limits within yards (which preclude the high throttle settings used for line-haul activity outside of yards); locomotive load (consists commonly move within yards with only one locomotive pulling and no trailing cars); and time spent either shut down or idling. Classification activities are carried out with duty cycles that are unique to yard operations and may vary from yard to yard. To develop more accurate emissions estimates, it is necessary to explicitly identify railyard activities at the level of individual locomotives.

Table 1. Locomotive Duty Cycles.

	Throttle Position (Percent Time in Notch)									
Duty Cycle	**D.B.**	**Idle**	**N1**	**N2**	**N3**	**N4**	**N5**	**N6**	**N7**	**N8**
EPA Line-Haul	12.5	38.0	6.5	6.5	5.2	4.4	3.8	3.9	3.0	16.2
EPA Switch	0.0	59.8	12.4	12.3	5.8	3.6	3.6	1.5	0.2	0.8
Trim Operations	0.0	44.2	5.0	25.0	2.3	21.5	1.5	0.6	0.0	0.0
Hump Pull-Back	0.0	60.4	12.5	12.4	5.9	3.6	3.6	1.5	0.0	0.0
Hump Push	0.0	0.0	0.0	100	0.0	0.0	0.0	0.0	0.0	0.0
Consist Movement	0.0	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0
Load Tests:										
10-Minute	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	80.0
15-Minute	0.0	33.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	66.7
30-Minute	0.0	33.3	33.3	0.0	0.0	0.0	0.0	0.0	0.0	33.3

To accomplish this, UPRR reviewed the types of databases available for its operations to identify where explicit emission-related activity information could be generated for the Davis Yard. UPRR operates approximately 7000 locomotives over a network spanning 23 states. Large amounts of data are generated and retained by UPRR for management purposes. These include tracking the location and status of capital assets (e.g., locomotives and rail cars), tracking performance of specific activities, and managing operations. These databases can be queried for data records specific to the Davis Yard, but their content does not directly relate to emissions. Where possible, data providing a complete record of emissions-related events (e.g., locomotive arrivals and departures) were identified and retrieved. Where 100 percent data for an activity could not be obtained (e.g., locomotive model number for each arriving locomotive), distributions were developed based on available data. In some cases, data are not available for specific types of emission events (e.g., the duration of idling for individual trains prior to departure). In these cases, UPRR yard personnel were consulted to derive estimates of averages or typical operating practices.

Railyard Operations – Inbound and Outbound Trains

The majority of locomotive activity in a railyard arises from inbound and outbound freight traffic. Following arrival, consists are decoupled from their trains in receiving areas and are either taken directly to outbound trains, or more commonly, are sent through servicing which can include washing, sanding, oiling, and minor maintenance prior to connecting to outbound trains. Some fraction of trains arriving at a yard simply pass through, possibly stopping briefly for a crew change. UPRR maintains a database that, when properly queried, can produce detailed information regarding both arriving and departing trains. Table 2 lists some of the key parameters that are available in this database. In this study, 12 months of data were obtained for all trains passing through the Davis Yard. The extracted data (over 60,000 records) included at least one record for every arriving and departing train, and each record contained specific information about a single locomotive, as well as other data for the train as a whole. The data were processed using a commercial relational database program and special purpose FORTRAN code to identify individual train arrivals and departures and train and consist characteristics.

Table 2. Selected Train Database Parameters.

	Used to Identify				
Parameter	Identification of Train Events	Location in Railyard	Consist Composition	Temporal Profile	Train Characteristics
Train Symbol	X	X			
Train Section	X				
Train Date	X				
Arrival or Departure	X	X			
Originating or Terminating	X	X			
Direction		X			
Crew Change?		X			
Arrival & Departure Times				X	
# of Locomotives			X		
# of Working Locomotives			X		
Trailing Tons					X
Locomotive ID #			X		
Locomotive Model			X		

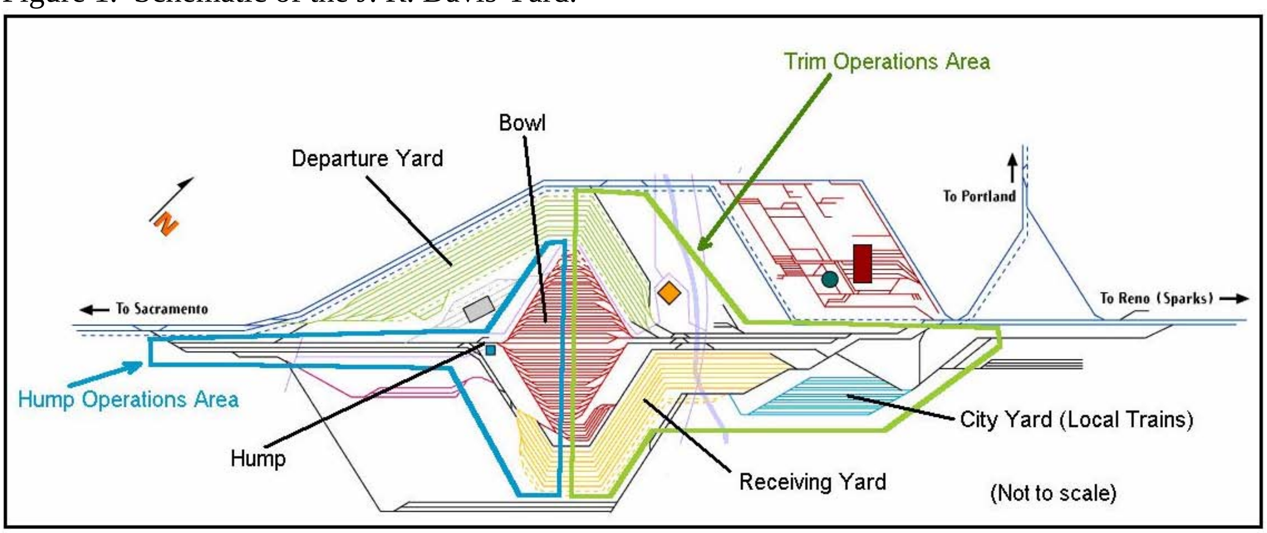
The parameters listed in Table 2 were used to calculate the number of trains by time of day arriving or departing from each area of the yard, as well as average composition of their consists (number of locomotives and distribution of locomotive models). The combination of train symbol, train segment, and train date provided a unique identifier for a single arrival or departure, and the individual locomotive models were tabulated to generate model distributions. Where necessary, working horsepower and total horsepower were used to estimate the number of working locomotives in the consist.

Emission calculations associated with inbound and outbound trains included both periods of movement within the yard boundaries and locomotive idling while consists we connected to their trains. Based on train direction and the location of its arrival or departure, moving emissions were based on calculations of time at different throttle settings based on distance traveled and estimated speed profiles, considering speed limits on different tracks. Yard operators provided estimates for the average duration of such idling for both inbound and outbound trains.

Railyard Operations – Classification

On arrival, inbound trains are “broken” into sections of rail cars destined for different outgoing trains. Figure 1 shows a schematic diagram of the Davis Yard including a large central “bowl” consisting of a large number of parallel tracks connected by automated switching controls to a single track to the west. Trains are pulled back to the west and then pushed to the “hump,” a slightly elevated portion of track just west of the bowl. As cars pass over the hump, they are disconnected and roll by gravity into the appropriate track in the bowl. Dedicated special purpose locomotives, known as “hump sets,” are used in this operation. Unlike most locomotives, these units have continuously variable throttles, rather than discrete throttle notch settings, to allow precise control of speed approaching the hump. Switching locomotives, known as “trim sets” are responsible for retrieving the train segments or trains being “built” in the bowl and moving them to the appropriate outbound track. The Davis Yard operates a fixed number of hump sets and trim sets at any given time, with backup sets standing by for shift changes and possible breakdowns.

Figure 1. Schematic of the J. R. Davis Yard.



Emission calculations for hump and trim operations were based on the number of working hump and trim sets at any given time, plus assumed idling times of standby units. For the hump sets, yard operators provided estimates of average pull-back and pushing times, and the duty cycles associated with these operations. For pull-back, based on distance and speed limits, the EPA switcher duty cycle, excluding notch 7 and 8 was used. Pushing is conducted at the equivalent of notch 2. For the trim sets, speed limits within the Yard preclude any high throttle setting operation, but there is a greater time spent in mid-throttle settings than reflected in the EPA switcher cycle. A revised duty cycle was developed for these units based on the EPA switcher duty cycle, with high throttle fractions (notches 7 and 8) excluded, but with increased notch 1 and notch 4 operating time. These duty cycles are also shown in Table 1.

Railyard Operations – Consist Movement, Service, Repair and Testing

After disconnecting from inbound trains, consists move to one of several servicing locations for refueling and other maintenance, following designated routes in the yard. Typically, one locomotive in each consist will pull the others, with throttle settings at notch 1 or 2. Based on distance and speed limits, movement times were estimated for each route, and emissions calculated using the number of locomotives following each route.

While being serviced, locomotives may be either idling or shut down. Locomotives must be idling while oil and other routine checks are performed. In addition, since locomotive engines are water-cooled and do not use antifreeze, they are commonly left idling during cold weather conditions. New idling reduction technologies known as SmartStart and AESS provide computer-controlled engine shut down and restart as necessary, considering temperature, air pressure, battery charge, and other parameters. Yard personnel provided estimates of the average potential duration of idling associated with different servicing events. Databases for service and maintenance activities maintained by UPRR provide details on the number and types of service events at different locations in the yard. As for train activity, these data were processed with a commercial relational database program and special purpose FORTRAN code to characterize and tabulate service events. These results were used in conjunction with data for the number of inbound and outbound consists to estimate total idling emissions for different service event types and locations. Following service, consists are dispatched to outbound trains. The same procedures were followed for estimating idle time, number of locomotives moving to each outbound area of the yard, and the duration of each movement for emission calculations.

In addition to routine service, the databases include service codes indicating periodic inspections of various types, as well as major maintenance activities requiring load testing of stationary locomotives. Several types of load tests are conducted, including planned maintenance pre- and post-tests, quarterly maintenance tests, and unscheduled maintenance diagnostic and post-repair tests. Depending on the test type and locomotive model, these tests include some period of idling, notch 1 operation, and notch 8 operation. Data are not collected on the exact duration of individual tests, so estimates of average duration for each throttle setting were provided by shop personnel, as shown in Table 1. The number of tests of each type for each locomotive model group were tabulated based on the service codes in the database for each service event.

Trends in Activity and Technology

The initial study was based on data from December 1999 through November 2000. Since that time, UPRR's locomotive fleet modernization program as well as changes in freight volumes have occurred. A subsequent data retrieval for the period from May 2003 through April 2004 was made, and emission calculations updated. A number of significant changes occurred over this 40-month period. The distribution of locomotive models in line-haul operation showed a substantial shift from older, lower horsepower units to new high horsepower units. The average number of locomotives per consist remained the same at about 3, but the higher horsepower allowed an increase in train capacity (trailing tons per train). The decrease in older units also resulted in a decrease in the frequency of major maintenance load testing. In addition to updating activity inputs (number of locomotives by model) for emission calculations, calculations were modified to reflect the penetration of new and retrofit technologies in the locomotive fleet, including SmartStart and AESS idling controls and Tier 0 and Tier 1 locomotives. UPRR data identifying the specific technologies installed on individual locomotives were matched with locomotive ID numbers in the train and servicing data retrievals to obtain a specific count of the number of locomotives of each model for which emissions reductions were achieved by these technologies. Historical temperature data for the Roseville area were used to estimate the fraction of time computer controls would require idling when the locomotive would otherwise be shut down.

EMISSION FACTORS

Data Sources

The study of the J. R. Davis Yard focused on diesel exhaust particulate matter emissions. At present, there is no unified database of emission test results for in-use locomotives. Appendix B of the USEPA's Regulatory Support Document for setting new emission standards for locomotives[2] contains a compilation of notch-specific emission factors. These data were supplemented by test data reported by Southwest Research Institute[3,4], as well as test data provided by locomotive manufacturers to assemble emission factors for each of 11 locomotive model groups.

There are dozens of specific locomotive model designations, and emissions tests are not available for all of them. However many models are expected to have nearly identical emission characteristics. Depending on their intended use, locomotives of different models may have different configurations (e.g., number of axles), but share a common diesel engine. For this project, 11 locomotive model groups were defined based on their engine models (manufacturer, horsepower, number of cylinders, and turbo- or super-charging of intake air). Table 3 lists these model groups and some of the typical locomotive models assigned to each group.

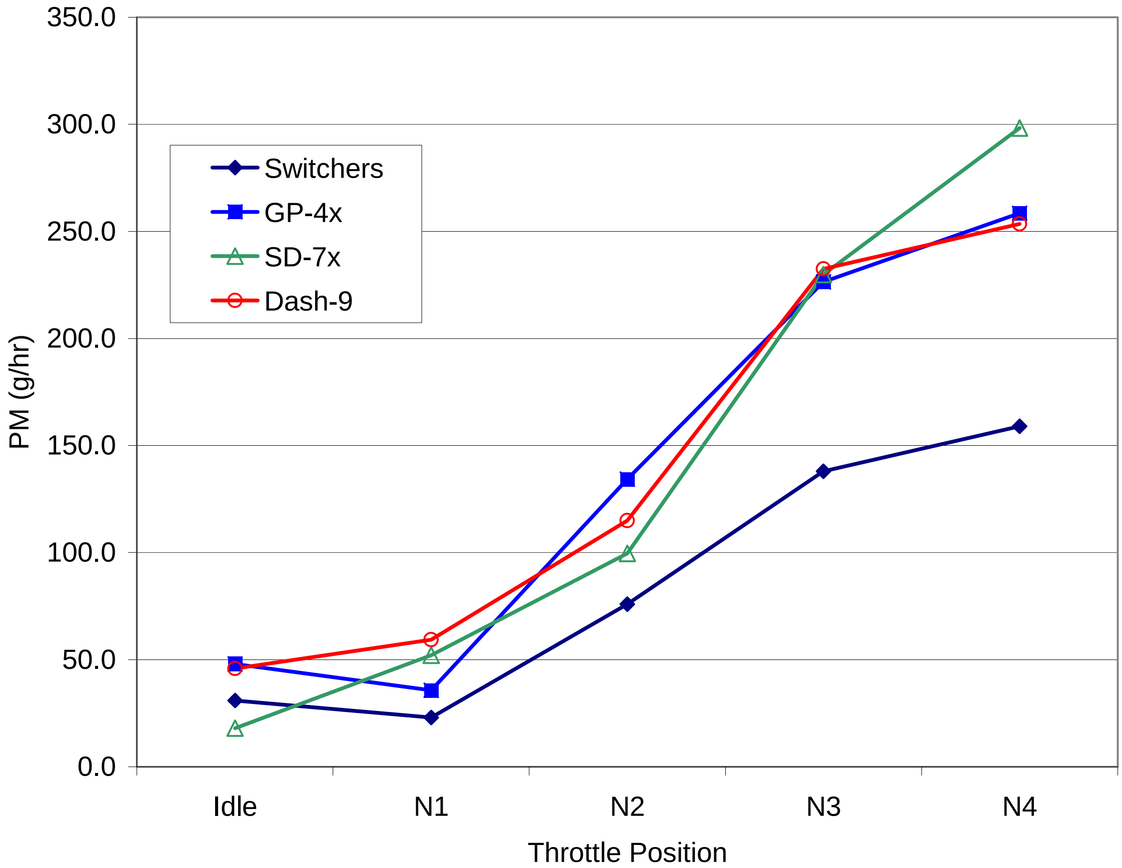
Table 3. Locomotive Model Groups

Model Group	Engine Family	Representative Models
Switchers	EMD 12-645E	GP-15, SW1500
GP-3x	EMD 16-645E	GP-30, GP-38
GP-4x	EMD 16-645E3B	GP-40, SD-40-2, SD-45-2
GP-50	EMD 16-645F3B	GP-50, SD-50M
GP-60	EMD 16-710G3A	GP-60, SD-60M
SD-7x	EMD 16-710G3B	SD-70MAC, SD-75
SD-90	EMD 16V265H	SD-90AC, SD-90-43AC
Dash-7	GE7FDL (12 cyl)	B23-7, B30-7, C36-7
Dash-8	GE7FDL (12 or 16 cyl)	B39-8, B40-8, C41-8
Dash-9	GE7FDL (16 cyl)	C44-9, C44AC
C60-A	GE7HDL	C60AC

Emission Factors and Fuel Effects

Figure 2 shows particulate matter (PM) emission factors for several of the more common locomotive model groups at the low to intermediate throttle settings typical of yard operations. As shown in the figure, emission rates generally increase with throttle setting. However, the older 3000 hp GP-4x series shows emissions comparable to (and in some cases, higher than) the newer 4000 to 4500 hp SD-7x and Dash-9 models. Due to the relatively large fraction of time locomotives spend at low throttle settings while in railyards, the relative differences in emission rates between models at these settings can significantly affect emissions estimates if locomotive model distributions change over time.

Figure 2. Locomotive PM Emission Factors (g/hr).

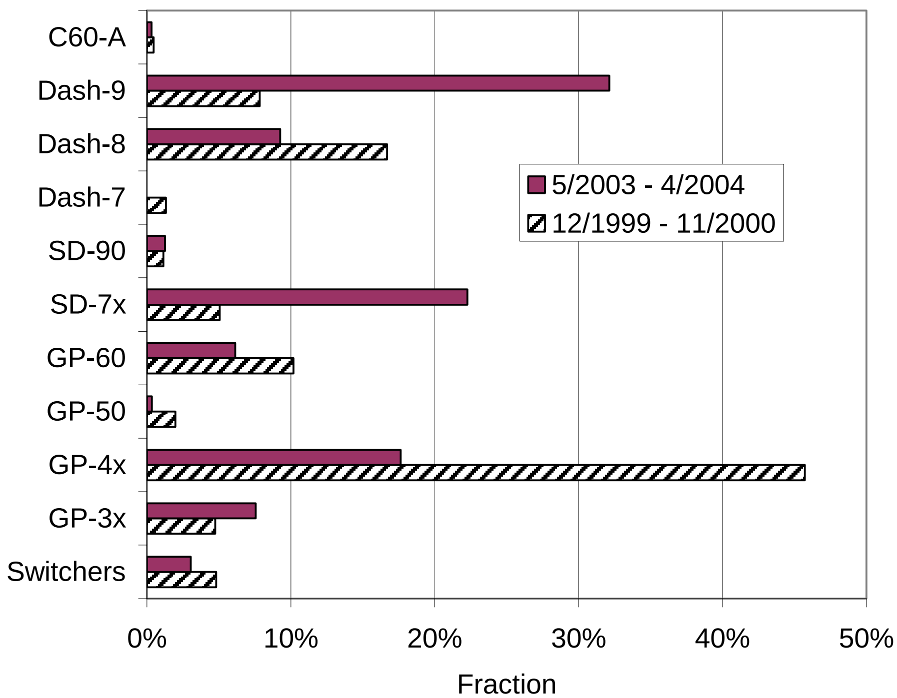


The emission factors used were based on tests using fuel typical of national off-road diesel. Initial emission estimates were derived by multiplying model-specific g/hr emission rates by the total hours of operation and locomotive model fraction for each activity within the yard. At the Davis Yard, over half of the diesel fuel dispensed to locomotives meets California on-road diesel fuel specifications (so-called "CARB diesel"). To account for the effect of fuel quality on emissions, estimates of the fraction of locally dispensed fuel burned by locomotives in different yard activities were developed. These ranged from 100 percent for hump and trim sets to zero percent for inbound line-haul units prior to refueling. These fractions were multiplied by the fraction of CARB diesel dispensed at the yard and an estimate of 14 percent reduction in PM emissions for locomotives burning CARB diesel to develop fuel effects adjustments for individual activities.

EMISSION TRENDS

Using the procedures described in the preceding sections, emissions estimates were developed for the December 1999 to November 2000 period, and the May 2003 to April 2004 period. During this period, significant changes in the UPRR locomotive fleet occurred, with the addition of new locomotives and the retirement of older units. Figure 3 shows the locomotive model distributions for all servicing events at the Davis Yard during these two periods. Service events include both the line-haul and local units arriving and departing on trains (which make up the bulk of these events), as well as the hump and trim sets. A significant increase in the relative fraction of high horsepower SD-7x and Dash-9 units is seen, and a corresponding decrease in the fraction of older GP-4x, GP-50, GP-60, Dash-7 and Dash-8 models. In addition to the fleet modernization, tabulations of specific emission control technologies on units serviced at the Davis Yard showed substantial penetration of new and retrofit technologies. Approximately 31 percent of locomotives serviced at the yard were equipped with computer-controlled shut-down and restart technology, resulting in reduced idling times. Also, approximately 27 percent of servicings were for Tier 0 locomotives, and approximately 25 percent were Tier 1 units. Although the Tier 0 and Tier 1 technologies are not expected to substantially reduce PM emissions, their nitrogen oxides emissions are lower. A few prototype Tier 2 units were observed in 2003 – 2004 data, and their reduced PM emissions will show benefits in the future.

Figure 3. Changes in Locomotive Model Distributions.



The freight volume passing through the yard also changed between these periods. Table 4 lists the percent change in the number of arriving and departing trains, locomotives, and trailing tons (a measure of freight volume). The number of trains and locomotives showed little change, however the trailing tons increased by approximately 15 percent, implying that the average train weight (and correspondingly, the required consist horsepower) increased. This is a result of the increased availability of high horsepower units in the UPRR fleet. A higher fraction of trains bypass the yard, either not stopping, or stopping only for crew changes.

Table 4. Percent Change in Yard Activity Levels from 12/1999 – 11/2000 to 5/2003 – 4/2004.

	Trains	**Locomotives**	**Trailing Tons**
Arrivals	-5.2%	-3.5%	--
Departures	-7.0%	-7.3%	--
Throughs (Bypassing the yard)	8.0%	6.8%	--
Total Arrivals and Departures	-0.3%	-0.9%	15.1%

The newer locomotive fleet also affected the level of load testing activity required. Table 5 lists the percent change in the number of load tests of different types, and the corresponding change in total locomotive testing time at idle, notch 1, and notch 8. The extended 30-minute post-maintenance tests were substantially reduced, and total hours of testing were reduced for the various throttle settings between 12 and 43 percent.

Table 5. Percent Change in Load Test Activity from 12/1999 – 11/2000 to 5/2003 – 4/2004.

10-Minute Tests	-18.9%
15-Minute Tests	14.6%
30-Minute Tests	-43.2%
Total Tests	-12.3%
Idling Hours	-20.6%
Notch 1 Hours	-43.2%
Notch 8 Hours	-12.0%

The combined net result of these changes is shown in Table 6. Between November 2000 and April 2003, total estimated PM emissions in the yard decreased by approximately 15 percent. Reductions in idling and movement emissions of about 20 percent were calculated, due to the combination of a newer, lower emitting locomotive fleet and the computer-controlled shutdown technologies (both retrofits and standard equipment on newer units). Hump and trim emissions were reduced by about 6 percent, and load testing emissions by about 14 percent.

Table 6. Emissions Changes from 12/1999 – 11/2000 to 5/2003 – 4/2004.

	Estimated Emissions (tons per year)		**Percent Change**
	12/1999 – 11/2000	**5/2003 – 4/2004**	
Idling and Movement of Trains	5.2	4.2	-20.3%
Idling and Movement of Consists	8.5	6.8	-20.2%
Testing	1.5	1.3	-14.1%
Hump and Trim	7.0	6.6	-5.7%
Total	22.3	18.9	-15.3%

CONCLUSIONS

Because of the unique features of each individual railyard, top-down methods (e.g., based only on tons of freight handled or number of arriving locomotives) cannot provide reliable estimates of railyard emissions. Yard-specific data are needed. In-yard activity patterns (and emissions) will vary between yards depending on factors such as: the type of yard (e.g., hump or flat switching classification yards, or intermodal facilities); the presence and capabilities of service tracks or locomotive repair shops; the types of freight handled; the location of the yard in the rail network; and yard configuration. The development of procedures for retrieving and analyzing activity data and locomotive characteristics for a specific railyard is a substantial improvement of alternatives based on top-down estimation. By obtaining disaggregate data for the range of specific activities occurring within railyards, it is possible to reliably estimate historical trends in emissions, as well as to evaluate the potential effects of operational changes and new technologies. Railyard operations cannot be treated in isolation, since these yards are only one component of complex national level systems. Nevertheless, the ability to assess the details of yard operations and their emissions provides an improved basis for environmental management decisions at both local and larger scales.

REFERENCES

1. Hand, R.; Di, P.; Servin, A.; Hunsaker, L.; Suer, C. *Roseville Rail Yard Study*, California Air Resources Board, Stationary Source Division, Sacramento, CA, October 14, 2004.

2. U. S. Environmental Protection Agency. *Locomotive Emission Standards – Regulatory Support Document,* U. S. Environmental Protection Agency, Office of Mobile Sources, April 1998.

3. Fritz, S. "Emissions Measurements – Locomotives", SwRI Project No. 08-5374-024, Prepared for the U.S. Environmental Protection Agency by Southwest Research Institute, San Antonio, TX, August 1995.

4. Fritz, S. "Diesel Fuel Effects on Locomotive Exhaust Emissions", SwRI Proposal No. 08-23088C, Prepared for the California Air Resources Board by Southwest Research Institute, San Antonio, TX, October 2000.

KEY WORDS

Emission inventories
Locomotives
Railyards
Diesel

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APPENDIX A-7

SULFUR ADJUSTMENT CALCULATIONS

Appendix A-7

Development of Adjustment Factors for Locomotive DPM Emissions Based on Sulfur Content

Wong (undated) provides equations for estimating g/bhp-hr emission rates for 4-Stroke (GE) and 2-Stroke (EMD) locomotives. Rather than using these statistically derived estimates for absolute emissions when model- and notch-specific emission factors are available, we used these equations to develop *relative* emission rate changes for different sulfur levels. The basic form of the equation is

$$q = a \cdot S + b$$

Where,

q is the predicted g/bhp-hr emission rate of a locomotive at a specific throttle setting and sulfur content;

a and b are coefficients specific to a locomotive type (2- or 4-stroke) and throttle notch; and

S is the fuel sulfur content in ppm.

Thus, to calculate the emission adjustment factor for a specific fuel sulfur content, it is necessary to calculate the nominal emission rate q_0 for the baseline fuel sulfur content S_0, and the emission rate q_i for the fuel of interest with sulfur content S_i. This adjustment factor k_i is simply

$$k_i = 1 - \frac{(q_0 - q_i)}{q_0},$$

Where, q_0 and q_i are calculated using the equation above. Tables 1 and 2 give the values of the a and b coefficients for 4-stroke and 2-stroke locomotives. For throttle settings below notch 3, sulfur content is not expected to affect emission rates. The baseline emission rates from which actual emissions are estimated were derived from emission tests of different locomotive models. Although full documentation of fuels is not available for all of these tests, they are assumed to be representative of actual emissions of the different models running on 3,000 ppm sulfur EPA non-road Diesel fuel. For the purposes of modeling 2005 emissions, these factors are needed to adjust the baseline emission factors to emission factors representative of two fuels – 221 ppm and 2639 ppm. Table 3 shows the resulting correction factors for these two fuels by notch and engine type. To generate locomotive model-, throttle-, tier-, and fuel-specific emission factors, the base case (nominal 3,000 ppm S) emission factors in Table 4 were multiplied by the corresponding correction factors for throttle settings between notch 3 and notch 8.

Table 1 **Sulfur Correction Coefficients for 4-Stroke Engines**		
Throttle Setting	***a***	***b***
Notch 8	0.00001308	0.0967
Notch 7	0.00001102	0.0845
Notch 6	0.00000654	0.1037
Notch 5	0.00000548	0.1320
Notch 4	0.00000663	0.1513
Notch 3	0.00000979	0.1565

Table 2 **Sulfur Correction Coefficients for 2-Stroke Engines**		
Throttle Setting	***a***	***b***
Notch 8	0.0000123	0.3563
Notch 7	0.0000096	0.2840
Notch 6	0.0000134	0.2843
Notch 5	0.0000150	0.2572
Notch 4	0.0000125	0.2629
Notch 3	0.0000065	0.2635

Table 3

DPM Emission Adjustment Factors for Different Fuel Sulfur Levels

Throttle Setting	4-Stroke (GE)		2-Stroke (EMD)	
	2,639 ppm S	221 ppm S	2,639 ppm S	221 ppm S
Notch 8	0.9653	0.7326	0.9887	0.9131
Notch 7	0.9662	0.7395	0.9889	0.9147
Notch 6	0.9809	0.8526	0.9851	0.8852
Notch 5	0.9867	0.8974	0.9821	0.8621
Notch 4	0.9860	0.8924	0.9850	0.8844
Notch 3	0.9810	0.8536	0.9917	0.9362

Table 4
Base Case Locomotive Diesel Particulate Matter Emission Factors (g/hr)
(3,000 PPM Sulfur Assumed)

Model Group	Tier	Throttle Setting: Idle	DB	N1	N2	N3	N4	N5	N6	N7	N8	Source
Switchers	N	31.0	56.0	23.0	76.0	138.0	159.0	201.0	308.0	345.0	448.0	EPA RSD[1]
GP-3x	N	38.0	72.0	31.0	110.0	186.0	212.0	267.0	417.0	463.0	608.0	EPA RSD[1]
GP-4x	N	47.9	80.0	35.7	134.3	226.4	258.5	336.0	551.9	638.6	821.3	EPA RSD[1]
GP-50	N	26.0	64.1	51.3	142.5	301.5	311.2	394.0	663.8	725.3	927.8	EPA RSD[1]
GP-60	N	48.6	98.5	48.7	131.7	284.5	299.4	375.3	645.7	743.6	941.6	EPA RSD[1]
GP-60	0	21.1	25.4	37.6	75.5	239.4	352.2	517.8	724.8	1125.9	1319.8	SwRI[2] (KCS733)
SD-7x	N	24.0	4.8	41.0	65.7	156.8	243.1	321.1	374.8	475.2	589.2	SwRI[3]
SD-7x	0	14.8	15.1	36.8	61.1	230.4	379.8	450.8	866.2	1019.1	1105.7	GM EMD[4]
SD-7x	1	29.2	31.8	37.1	66.2	219.3	295.9	436.7	713.2	783.2	847.7	SwRI[5] (NS2630)
SD-7x	2	55.4	59.5	38.3	134.2	271.7	300.4	335.2	551.5	672.0	704.2	SwRI[5] (UP8353)
SD-90	0	61.1	108.5	50.1	99.1	255.9	423.7	561.6	329.3	258.2	933.6	GM EMD[4]
Dash 7	N	65.0	180.5	108.2	121.2	359.5	327.7	331.5	299.4	336.7	420.0	EPA RSD[1]
Dash 8	0	37.0	147.5	86.0	133.1	291.4	293.2	327.7	373.5	469.4	615.2	GE[4]
Dash 9	N	32.1	53.9	54.2	108.1	219.9	289.1	370.6	437.7	486.1	705.7	SWRI 2000
Dash 9	0	33.8	50.7	56.1	117.4	229.2	263.8	615.9	573.9	608.0	566.6	Average of GE & SwRI[6]
Dash 9	1	16.9	88.4	62.1	140.2	304.0	383.5	423.9	520.2	544.6	778.1	SwRI[2] (CSXT595)
Dash 9	2	7.7	42.0	69.3	145.8	304.3	365.0	405.2	418.4	513.5	607.5	SwRI[2] (BNSF 7736)
C60-A	0	71.0	83.9	68.6	78.6	277.9	234.1	276.0	311.4	228.0	362.7	GE[4] (UP7555)

Notes:

1. EPA Regulatory Support Document, "Locomotive Emissions Regulation," Appendix B, 12/17/97, as tabulated by ARB and ENVIRON
2. Base emission rates provided by ENVIRON as part of the BNSF analyses for the Railyard MOU (Personal communication from Chris Lindhjem to R. Ireson, 2006) based on data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to C. Lindhjem, 2006).
3. SwRI final report "Emissions Measurments – Locomotives" by Steve Fritz, August 1995.
4. Manufacturers' emissions test data as tabulated by ARB.
5. Base SD-70 emission rates taken from data produced in the AAR/SwRI Exhaust Plume Study (Personal communication from Steve Fritz to R. Ireson, 2006).
6. Average of manufacturer's emissions test data as tabulated by ARB and data from the AAR/SwRI Exhaust Plume Study, tabulated and calculated by ENVIRON..

OFFROAD Modeling Change Technical Memo

SUBJECT: Changes to the Locomotive Inventory

LEAD: Walter Wong

Summary

The statewide locomotive emission inventory has not been updated since 2002. Using the Booz-Allen Hamilton's (BAH) study (Locomotive Emission Study) published in 1992 as a guideline (summary of inventory methodology can be found in Appendix A), staff updated the locomotive inventory.

The history of locomotive emission inventory updates began in 1992 using the results from the BAH report as the baseline inventory. In 2003, staff began updating the emissions inventory by revising the growth assumptions used in the inventory. The revised growth factors were incorporated into the ARB's 2003 Almanac Emission Inventory. With additional data, staff is proposing further update to the locomotive inventory to incorporate fuel correction factors, add passenger train data and Class III locomotives. Changes from updated locomotive activity data have made a significant impact on the total inventory (see Table 1).

Table 1. Impact of Changes on Statewide Locomotive Inventory

	Pre 2003 ARB Almanac Inventory (tons/day)			Revised Inventory (tons/day)			Difference (tons/day)		
Year	HC	NOx	PM	HC	NOx	PM	HC	NOx	PM
1987	7.2	158.8	3.6	7.2	158.8	3.6	0.0	0.0	0.0
2000	7.2	144.8	2.8	9.8	207.2	4.7	2.6	62.4	1.9
2010	7.2	77.8	2.8	9.5	131.9	4.2	2.3	54.1	1.4
2020	7.2	77.8	2.8	9.4	134.6	4.1	2.2	56.8	1.3

Reasons For Change

During the 2003 South Coast's State Implementation Plan (SIP) development process, industry consultants approached Air Resources Board (ARB) staff to refine the locomotive emissions inventory. Specifically, their concerns were related to the growth factors and fuel correction factors used in the inventory calculations. This document outlines how the locomotive emissions inventory was updated and the subsequent changes made to address industry's concerns.

Background : Baseline 1987 Locomotive Emissions Inventory (BAH report)

Locomotive operations can be characterized by the type of service performed. For emission inventory purposes, locomotives are classified into five different service types as defined in BAH's report.

> Line-haul/intermodal – Intermodal locomotives generally operate at higher speeds and with higher power than other types and incorporate modern, high-speed engines.
>
> Mixed/bulk – Mixed locomotives are the most common and operate with a wide range of power. They also perform line-haul duties.
>
> Local/Short Haul – Local locomotives perform services that are a mixture of mixed freight and yard service. They operate with lower power and use older horsepower engines.
>
> Yard/Switcher – Yard operations are used in switching locomotives and characterized by stop and start type movements. They operate with smaller engines and have the oldest locomotive engines.
>
> Passenger – Passenger locomotives are generally high speed line haul type operations.

Categories of railroads are further explained by a precise revenue-based definition found in the regulations of the Surface Transportation Board (STB). Rail carriers are grouped into three classes for the purposes of accounting and reporting:

> Class I –Carriers with annual operating revenues of $250 million or more
>
> Class II – Carriers with annual operating revenues of less than $250 million but in excess of $20 million
>
> Class III – Carriers with annual operating revenues of less than $20 million or less, and all switching companies regardless of operating revenues.

The threshold figures are adjusted annually for inflation using the base year of 1991.

The 1987 locomotive inventory as shown in Table 2 is taken from the BAH report prepared for the ARB entitled “Locomotive Emission Study” completed in 1992 (http://www.arb.ca.gov/app/library/libcc.php). Information was gathered from many sources including ARB, the South Coast Air Quality Management District, the California Energy Commission, the Association of American Railroads (AAR), locomotive and large engine manufacturers, and Southwest Research Institute. Railroad companies, such as Southern Pacific, Union Pacific, and Atchison, Topeka and Santa Fe (ATSF), provided emission factors, train operation data, and throttle position profiles for trains operating in their respective territories. Southwest Research Institute provided emission test data.

Table 2. 1987 Locomotive Inventory in Tons Per Day, Statewide, BAH report

TYPE	HC	CO	NOX	PM	SOX
Line-Haul/Intermodal	3.97	12.89	86.21	1.97	6.36
Short-Haul/Local	0.96	3.06	21.30	0.46	1.59
Mixed	1.51	4.85	37.34	0.81	2.76
Passenger	0.10	0.22	3.24	0.07	0.30
Yard/Switcher	0.62	1.57	10.69	0.24	0.58
Total	7.16	22.59	158.78	3.55	11.59

The assumed average fuel sulfur content is 2700 parts per million (ppm) obtained from the BAH report.

Current Growth Estimates

Prior to the 2003 South Coast SIP update, growth factors were based on employment data in the railroad industry. Staff believes that the use of historic employment data, which translates to a decline in emissions in future years, may be masking actual positive growth in locomotive operations. It may be assumed that the number of employees is declining due to increased efficiency.

Changes to the Locomotive Inventory

Summary of Growth in Emission Based on BAH Report

Growth is estimated based on train operation type and by several operating characteristics.

> Increased Rail Lube and Aerodynamics – this arises from reduction in friction and will help reduce power requirements.

Introduction of New Locomotives – older locomotive units will be replaced by newer models.

Changes in Traffic Level – the increase or decrease in railroad activity

In the BAH report, projected emission estimates for years 2000 and 2010 were based on the factors shown in Tables 3 and 4. A substantial part of the locomotive emission inventory forecast is based upon projections of rail traffic levels. BAH projected future rail traffic level as a function of population and economic growth in the state. BAH also projected growth in emission only to 2010.

Table 3. Changes in Emissions from 1987-2000 (Exhibit 4 p. 11 of the 8/92 Locomotive Emission Study Supplement) (1987 Base Year)

Train Operation Type	Increased Rail Lube and Aerodynamics	Introduction of New Locomotive	Changes in Traffic Levels	Cumulative Net Growth in Emissions
Intermodal	-7.0%	-8.0%	17.0%	2.0%
Mixed & Bulk	-7.0%	-8.0%	2.0%	-13.0%
Local	-3.0%	-3.0%	-2.0%	-8.0%
Yard	0.0%	-1.0%	-25.0%	-26.0%
Passenger	-7.0%	-8.0%	10.0%	-5.0%

Table 4. Changes in Emissions from 2001-2010 (Exhibit 4 p. 11 of the 8/92 Locomotive Emission Study Supplement) (2000 Base Year)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Introduction of New Locomotive	Changes in Traffic Levels	Cumulative Net Growth in Emissions
Intermodal	-2.0%	-3.0%	-8.0%	25.0%	12.0%
Mixed & Bulk	-2.0%	-3.0%	-8.0%	0.0%	-13.0%
Local	-1.0%	0.0%	-12.0%	-10.0%	-23.0%
Yard	0.0%	0.0%	-10.0%	-15.0%	-25.0%
Passenger	-2.0%	-3.0%	-8.0%	15.0%	2.0%

BAH added “Improved Dispatching and Train Control” to differentiate these impacts from the “Increased Rail Lubing” which helps to improve fuel efficiency from locomotive engines. Since train control techniques are emerging from the signal company research work, these assumed changes will not impact emission until year 2000.

Based on industry's input, staff recommends several changes to the locomotive emissions inventory. These include modifying growth factors, making adjustments to control factors reflecting the U. S. EPA regulations that went into effect in year 2000, incorporating fuel correction factors, adding smaller class III railroad and industrial locomotive, and updating passenger data.

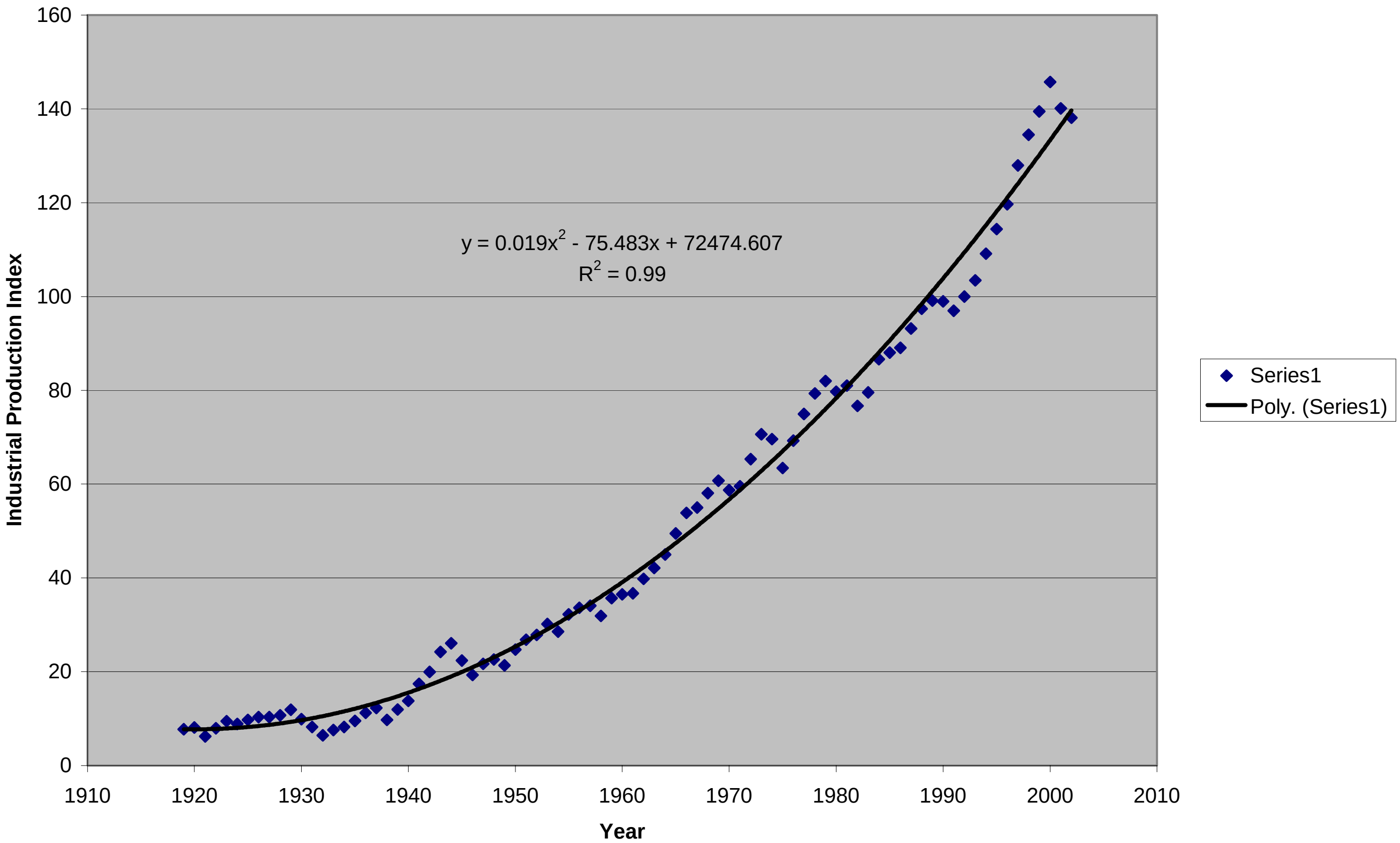
Revised Growth in Emissions

Staff revised the growth factors for locomotives based on new data that better reflect locomotive operations. This includes U.S. industrial production and various railroad statistics available from the AAR.

Based on historic data recently obtained from U.S. industrial productions and the AAR, the changes in traffic levels were revised. A better estimate for changes in traffic levels for locomotives can be made to the line-haul class of railroad, which are the intermodal and mixed and bulk type of locomotives, using industrial production and AAR's data.

Industrial production data is considered to be a surrogate for changes in traffic levels of the line-haul locomotive. It is assumed that railroad activity would increase in order to accommodate the need to move more product. Industrial production is the total output of U.S. factories and mines, and is a key economic indicator released monthly by the Federal Reserve Board. U.S. industrial production historical data from 1920 to 2002 was obtained and analyzed from government sources. Figure 1 shows the historical industrial production trend (Source : http://www.research.stlouisfed.org/fred2/series/INDPRO/3/Max). Statistical analysis was used to derive a polynomial equation to fit the data.

Figure 1. Long-term Industrial Production



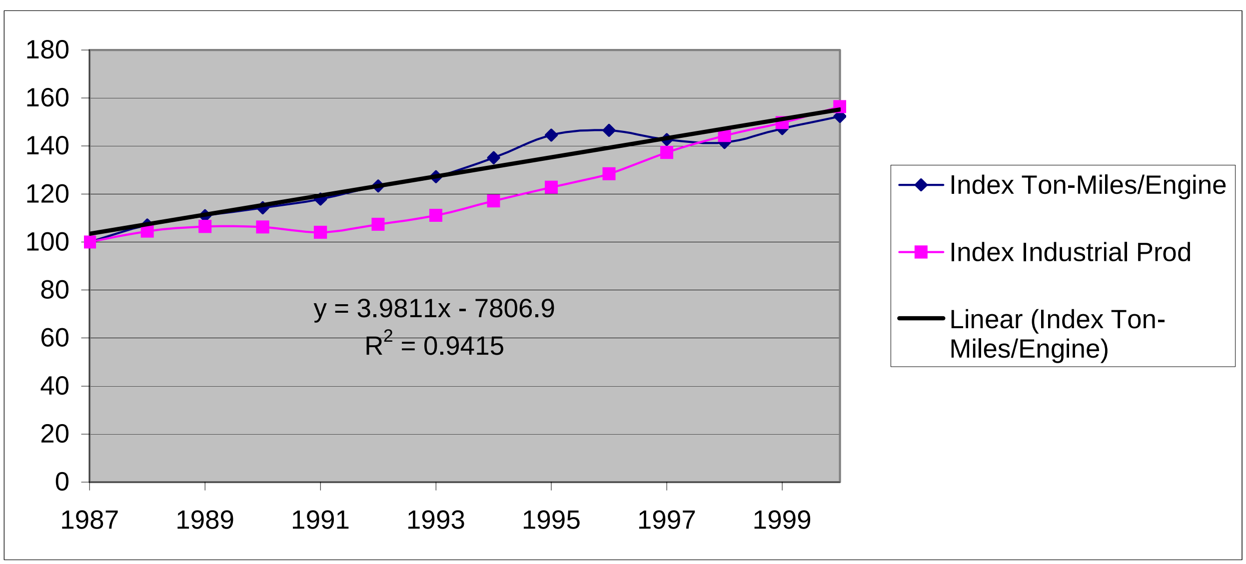
Another surrogate for growth is net ton-miles per engine. Consequently, staff analyzed railroad data from the AAR's Railroad Facts booklet (2001 edition). The booklet contains line-haul railroad statistics including financial status, operation and employment data, and usage profiles. Revenue ton-mile and locomotives in service data from the booklet were used to compute the net ton-miles per engine as shown in Table 5.

Table 5. Revenue Ton-Miles and Ton-Miles/Engine (AAR Railroad Facts 2001 edition)

Year	Locomotive Diesel in Service (US)	Revenue Ton-Miles	Ton-Miles/Engine
1987	19,647	943,747	48.04
1988	19,364	996,182	51.45
1989	19,015	1,013,841	53.32
1990	18,835	1,033,969	54.90
1991	18,344	1,038,875	56.63
1992	18,004	1,066,781	59.25
1993	18,161	1,109,309	61.08
1994	18,496	1,200,701	64.92
1995	18,810	1,305,688	69.41
1996	19,267	1,355,975	70.38
1997	19,682	1,348,926	68.54
1998	20,259	1,376,802	67.96
1999	20,254	1,433,461	70.77
2000	20,026	1,465,960	73.20

As shown in Figure 2, there is a relatively good correlation between net ton-miles per engine growth and industrial production. Because net ton-miles per engine data are compiled by the railroad industry and pertains directly to the railroad segment, staff believes that net ton-miles per engine will better characterize future traffic level changes.

Figure 2. Ton-miles/Engine vs. Industrial Production (index base year = 1987)



The ton-miles/engine data were projected to calculate the future growth rate of traffic level using a linear equation.

Staff also made changes to the “Increased Rail Lube and Aerodynamics” assumption shown in Tables 3 and 4. Rail lubing does not benefit the idling portion of locomotive activity. Since idling contributes 20% of the weighting in the line-haul duty cycle, staff reduced the rail lubing benefit by 20%. Meanwhile, improved dispatching and train control is assumed only to reduce engine idling. Therefore, staff reduced the improved dispatching benefit by 80%.

The benefit of the introduction of new locomotives to the fleet was decreased from the original BAH assumption. BAH assumed 50% penetration of the new engines by 2000. Literature research suggests that the new engines accounted for only about 34% of the fleet in 2000 (www.railwatch.com, http://utahrails.net/all-time/modern-index.php). These new engines are assumed to be 15% cleaner. Therefore, the benefit from new locomotive engines has been reduced to 5% (34% x 15% = 5% reduction).

Tables 6, 7, and 8 present the revised growth factors to be used to project the baseline (1987) locomotive emissions inventory into the future.

Table 6. ARB Revised Growth 1987-2000, ARB’s 2003 Almanac Emission Inventory

Train Operation Type	Increased Rail Lube and Aerodynamics	Introduction of New Locos	Population Increase	Changes in Traffic Levels	Cumulative Net Growth in Emissions	Annual Growth
Intermodal	-5.6%	-5.1%	1.9%	50.0%	41.2%	2.69%
Mixed & Bulk	-5.6%	-5.1%	1.9%	50.0%	41.2%	2.69%
Local	-2.4%	0%	0%	-2.0%	-4.4%	-0.35%
Yard	0.0%	0%	0%	-25.0%	-25.0%	-2.19%
Passenger	-5.6%	0%	1.9%	10.0%	6.3%	0.47%

The benefit of new locomotives with cleaner burning engines is accounted for in the control factor from EPA’s regulation beginning in 2001, which takes into account introduction of new locomotive engines meeting Tier I and Tier II standards.

Table 7. ARB Revised Growth 2001-2010 (2000 Base Year, ARB's 2003 Almanac Emission Inventory)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Changes in Traffic Levels	Cumulative Net Growth in Emissions	Annual Growth
Intermodal	-1.6%	-0.6%	22.5%	20.3%	1.87%
Mixed & Bulk	-1.6%	-0.6%	22.5%	20.3%	1.87%
Local	-0.8%	-0.6%	-10.0%	-11.4%	-1.20%
Yard	0.0%	0.0%	-15.0%	-15.0%	-1.61%
Passenger	-1.6%	0.0%	15.0%	13.4%	1.27%

Table 8. ARB Revised Growth 2010-2020 (2010 Base Year, ARB's 2003 Almanac Emission Inventory)

Train Operation Type	Increased Rail Lube and Aerodynamics	Improved Dispatching and Train Control	Changes in Traffic Levels	Cumulative Net Growth	Annual Growth
Intermodal	0.0%	0.0%	18.0%	18.0%	1.67%
Mixed & Bulk	0.0%	0.0%	18.0%	18.0%	1.67%
Local	0.0%	0.0%	0.0%	0.0%	0.00%
Yard	0.0%	0.0%	0.0%	0.0%	0.00%
Passenger	0.0%	0.0%	0.0%	0.0%	0.00%

In Table 8, staff assumes no benefit from aerodynamics and improved train controls. Staff seeks guidance from industry as to their input regarding future benefits.

Table 9. Revised Growth in Emissions (Base Year 1987)

Year	Intermodal	Mixed & Bulk	Local	Yard	Passenger
1987	1.00	1.00	1.00	1.00	1.00
1988	1.03	1.03	1.00	0.98	1.00
1989	1.05	1.05	0.99	0.96	1.01
1990	1.08	1.08	0.99	0.94	1.01
1991	1.11	1.11	0.99	0.92	1.02
1992	1.14	1.14	0.98	0.90	1.02
1993	1.17	1.17	0.98	0.88	1.03
1994	1.20	1.20	0.98	0.86	1.03
1995	1.24	1.24	0.97	0.84	1.04
1996	1.27	1.27	0.97	0.82	1.04
1997	1.30	1.30	0.97	0.80	1.05
1998	1.34	1.34	0.96	0.78	1.05
1999	1.38	1.38	0.96	0.77	1.06
2000	1.41	1.41	0.96	0.75	1.06
2001	1.44	1.44	0.94	0.74	1.08
2002	1.47	1.47	0.93	0.73	1.09
2003	1.49	1.49	0.92	0.71	1.10
2004	1.52	1.52	0.91	0.70	1.12
2005	1.55	1.55	0.90	0.69	1.13
2006	1.58	1.58	0.89	0.68	1.15
2007	1.61	1.61	0.88	0.67	1.16
2008	1.64	1.64	0.87	0.66	1.18
2009	1.67	1.67	0.86	0.65	1.19
2010	1.70	1.70	0.85	0.64	1.21
2011	1.73	1.73	0.85	0.64	1.21
2012	1.76	1.76	0.85	0.64	1.21
2013	1.79	1.79	0.85	0.64	1.21
2014	1.81	1.81	0.85	0.64	1.21
2015	1.85	1.85	0.85	0.64	1.21
2016	1.88	1.88	0.85	0.64	1.21
2017	1.91	1.91	0.85	0.64	1.21
2018	1.94	1.94	0.85	0.64	1.21
2019	1.97	1.97	0.85	0.64	1.21
2020	2.00	2.00	0.85	0.64	1.21

Control Factors for U.S. EPA regulation

In December 1997, the U.S. EPA finalized the locomotive emission standard regulation. The regulatory support document lists the control factors used (http://www.epa.gov/otaq/regs/nonroad/locomotv/frm/locorsd.pdf). Staff modified the control factors to incorporate the existing memorandum of understanding (http://www.arb.ca.gov/msprog/offroad/loco/loco.htm) between the South Coast AQMD and the railroads that operate in the region. Previously, one control factor was applied statewide. In the revised emissions inventory starting in 2010, a lower control factor reflecting the introduction of lower emitting locomotive engines in the SCAB region was applied. Tables 10 and 11 show the revised control factors. Road hauling definition as used by U.S. EPA applies to the line-haul/intermodal, mixed, and local/short haul train type in the emissions inventory.

Table 10. Revised Statewide Control Factors

Year	State Road Hauling HC	State Road Hauling NOx	State Road Hauling PM	State Switcher HC	State Switcher NOx	State Switcher PM	State Passenger HC	State Passenger NOx	State Passenger PM
1999	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2000	1.00	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2001	1.00	0.95	1.00	1.00	1.00	1.00	1.00	1.00	1.00
2002	1.00	0.88	1.00	1.00	0.98	1.00	1.00	0.98	1.00
2003	1.00	0.82	1.00	1.00	0.97	1.00	1.00	0.96	1.00
2004	1.00	0.75	1.00	1.00	0.95	1.00	1.00	0.94	1.00
2005	0.96	0.68	0.96	0.99	0.93	0.99	0.98	0.92	0.98
2006	0.92	0.62	0.92	0.99	0.91	0.99	0.96	0.90	0.96
2007	0.89	0.59	0.89	0.98	0.89	0.98	0.94	0.83	0.94
2008	0.87	0.57	0.86	0.98	0.87	0.97	0.92	0.76	0.92
2009	0.84	0.55	0.84	0.97	0.85	0.97	0.91	0.69	0.90
2010	0.82	0.54	0.81	0.96	0.83	0.96	0.89	0.62	0.88
2011	0.81	0.53	0.80	0.96	0.81	0.95	0.87	0.57	0.87
2012	0.80	0.53	0.79	0.95	0.79	0.94	0.85	0.56	0.85
2013	0.79	0.52	0.78	0.94	0.77	0.93	0.83	0.54	0.83
2014	0.77	0.51	0.76	0.94	0.75	0.93	0.82	0.53	0.81
2015	0.76	0.50	0.75	0.93	0.73	0.92	0.80	0.52	0.79
2016	0.75	0.50	0.74	0.92	0.71	0.91	0.78	0.51	0.77
2017	0.74	0.49	0.72	0.91	0.70	0.90	0.76	0.50	0.75
2018	0.73	0.48	0.71	0.90	0.69	0.89	0.74	0.49	0.73
2019	0.71	0.48	0.70	0.89	0.68	0.88	0.73	0.48	0.71
2020+	0.70	0.47	0.69	0.89	0.67	0.87	0.71	0.47	0.69

Table 11. Revised SCAB Control Factors

Year	SCAB Road Hauling HC	SCAB Road Hauling NOx	SCAB Road Hauling PM	SCAB Switcher HC	SCAB Switcher NOx	SCAB Switcher PM
1999	1.00	1.00	1.00	1.00	1.00	1.00
2000	1.00	0.99	1.00	1.00	1.00	1.00
2001	1.00	0.95	1.00	1.00	1.00	1.00
2002	1.00	0.88	1.00	1.00	0.98	1.00
2003	1.00	0.82	1.00	1.00	0.97	1.00
2004	1.00	0.75	1.00	1.00	0.95	1.00
2005	0.96	0.68	0.96	0.99	0.93	0.99
2006	0.92	0.62	0.92	0.99	0.91	0.99
2007	0.89	0.59	0.89	0.98	0.89	0.98
2008	0.87	0.57	0.86	0.98	0.87	0.97
2009	0.84	0.55	0.84	0.97	0.85	0.97
2010	0.82	0.36	0.81	0.96	0.36	0.96
2011	0.81	0.36	0.80	0.96	0.36	0.95
2012	0.80	0.36	0.79	0.95	0.36	0.94
2013	0.79	0.36	0.78	0.94	0.36	0.93
2014	0.77	0.36	0.76	0.94	0.36	0.93
2015	0.76	0.36	0.75	0.93	0.36	0.92
2016	0.75	0.36	0.74	0.92	0.36	0.91
2017	0.74	0.36	0.72	0.91	0.36	0.90
2018	0.73	0.36	0.71	0.90	0.36	0.89
2019	0.71	0.36	0.70	0.89	0.36	0.88
2020+	0.70	0.36	0.69	0.89	0.36	0.87

Addition of Class III Locomotive and Industrial/Military Locomotive

The annual hours operated by the class III railroads are shown in Table 12. The results were tabulated from ARB Stationary Source Division's (SSD) survey (http://www.arb.ca.gov/regact/carblohc/carblohc.htm) conducted to support regulation with regards to ARB ultra-clean diesel fuel.

Table 12. Short-Haul and Switcher Annual Hours for Class III Railroads

Air Basin	Operations	Population	Annual Hours Operated
Mountain Counties	SW	2	10214
Mojave Desert	L	10	27440
North Coast	L	3	5700
North Central Coast	L	1	1332
	SW	3	3996
Northeast Plateau	L	5	9892
South Coast	SW	21	75379
South Central Coast	L	5	3200
San Diego	L	4	5000
San Francisco	L	8	31600
	SW	4	5059
San Joaquin Valley	L	29	68780
	SW	19	72248
Sacramento Valley	L	6	11400
Total		120	331240

L = local short-haul, SW = switcher

The short-haul and switcher emission rate are derived from BAH report. The report cites studies from testing done at EPA and Southwest Research Institute.

Table 13. Short-Haul and Switcher Emission Rate

Emission Rate	Short-Haul (g/bhp-hr)	Switcher (g/bhp-hr)
HC	0.38	0.44
CO	1.61	1.45
NOx	12.86	15.82
PM	0.26	0.28
SOx	0.89	0.90
Fuel Rate (lb/hr)	120.00	60.00

Table 14. Statewide Summary of Industrial Locomotives

Air Basin	Number of Locomotives	Avg. HP	Avg. Age
Mojave Desert	9	1,138	56
Others	11	587	54
San Francisco	11	525	54
San Joaquin Valley	38	1,176	54
South Coast	24	1,290	55
TOTALS	93	1,055	55

Table 15. Statewide Summary of Military Locomotives

Air Basin	Number of Locomotives	Avg. HP	Avg. Age
Mojave Desert	7	900	50
Northeast Plateau	2	1,850	50
Sacramento Valley	1	500	50
San Diego	7	835	50
San Francisco	4	1525	47.5
San Joaquin Valley	2	400	50
South Central Coast	1	500	50
TOTALS	24	930	49.6

The data from the survey provides a reasonable depiction of railroad activities in 2003. To forecast and backcast, an assumption was made to keep the data constant and have no growth. More research is needed to quantify the growth projections of smaller, local railroad activities.

Update to Passenger Trains

ARB's survey of intrastate locomotives included passenger agency trains that operated within the state. Staff attempted to reconcile the survey results by calculating the operation schedules posted by the operating agency to obtain hours of operation and mileage information. The results of the survey and calculated operating hours were comparable. Table 16 lists the calculated annual hours operated and miles traveled used to estimate emissions.

Table 16. Passenger Trains Annual Miles and Hours

Air Basin	Annual Miles Operated	Annual Hours Operated
South Coast	3,700,795	92,392
South Central Coast	151,864	4,020
San Diego	914,893	25,278
San Francisco	2,578,862	77,944
San Joaquin Valley	674,824	17,313
Sacramento Valley	635,384	20,058
Total	8,656,621	237,006

The passenger train emission rate is derived from testing done at SWRI on several passenger locomotives.

Table 17. Passenger Train Emission Rate

Emission Rate	Passenger Train (g/bhp-hr)
HC	0.50
CO	0.69
Nox	12.83
PM	0.36
Sox	0.90
Fuel Rate (lb/hr)	455.00

Fuel Correction Factors

Aromatics

Previous studies quantifying the effects of lowering aromatic content are listed in Table 18. These studies tested four-stroke heavy-duty diesel engines (HDD). Although staff would have preferred to analyze data from tests performed on various locomotive engines to determine the effects of lower aromatics, these HDD tests are the best available resources to determine the fuel corrections factors due to lower aromatics.

Table 18. Effect of Lowering Aromatic Volume on PM Emission

STUDY	**Sulfur (ppm)**	**Aromatics (Volume %)**	**PM Reduction (%)**
Chevron (1984)	2,800	31	Baseline
Chevron (1984)	500	31	23.8
Chevron (1984)	500	20	32.2
Chevron (1984)	500	15	36.0
Chevron (1984)	500	10	39.9
CRC-SWRI (1988)	500	31	Baseline
CRC-SWRI (1988)	500	20	9
CRC-SWRI (1988)	500	15	13
CRC-SWRI (1988)	500	10	17

Source : http://www.arb.ca.gov/fuels/diesel/diesel.htm

Using a linear regression of the data from the Table 18, the PM reduction from a change in aromatic content can be described as :

<u>4-Stroke Engine</u>
PM reduction = [(Difference in Aromatic Volume) * 0.785 + 0.05666]/100

For 2-Stroke engines, staff used test data from SWRI's report published in 2000 entitled "Diesel Fuel Effects on Locomotive Exhaust Emissions" to estimate indirectly the potential PM reduction for 2-Stroke engines due to lower aromatics. Table 19 lists the summary of the test results.

Table 19. SWRI 2000 Study Summary Results

Locomotive Engine	Aromatic Changes (Volume %)	PM Difference (g/bhp-hr)	PM % Difference
4 Stroke	28.35 to 21.84	0.080	37.6%
2 Stroke	28.35 to 21.84	0.056	14.1%

Staff assumes that PM emission reduction from 2-Stroke engine will have a factor of 0.38 (14.1%/37.6%) to the 4-Stroke engine PM emission reduction.

Currently, the baseline locomotive emissions inventory assumes an aromatic total volume percent of 31%. Table 21 describes the changes in PM emission due to changes in total volume percent of aromatics.

Table 20. Examples of PM Reductions Due to Changes in Aromatic Total Volume Percent

Aromatic Volume Percent		PM Reduction	PM Reduction	PM Reduction
From	To	2 Stroke	4 Stroke	Composite
31	28	0.9%	2.4%	1.3%
31	19	3.6%	9.5%	5.1%
31	10	6.3%	16.5%	8.9%

*composite is 75% 2 Stroke Engine and 25% 4 Stroke Engine

Table 21,Table 22, and Table 23 show the PM emission reduction for the different type of fuels used in the state.

Table 21. PM Emission Percent Change of Line-Haul Due to Aromatics, Statewide

Calendar Year	CARB Aromatic Volume (%)	EPA Aromatic Volume (%)	Off-road Aromatic Volume (%)	Weighted Aromatic Volume (%)	PM Emission Percent Change
1992	31	31	31	31.00	0.00
1993	10	31	31	31.00	0.00
1994	10	31	31	31.00	0.00
1995	10	31	31	31.00	0.00
1996	10	31	31	31.00	0.00
1997	10	31	31	31.00	0.00
1998-2001	10	31	31	30.18	-0.004
2002-2006	10	31	31	29.05	-0.009
2007+	10	31	31	29.05	-0.009

Table 22. Class I Line Haul Weighted Aromatic Volume Percent by Air Basin

Interstate Locomotive	Air Basin	1993-2001 Weighted Aromatic	2002+ Weighted Aromatic
		Volume Percent	Volume Percent
Class I Line Haul	SCC	31.0	31.0
	MC	31.0	26.6
	MD	30.0	29.8
	NEP	31.0	27.9
	SC	31.0	31.0
	SF	28.6	23.1
	SJV	29.1	29.4
	SS	31.0	31.0
	SV	31.0	27.4

Table 23. PM Emission Reduction from Intrastate Locomotives Due to Aromatics by Air Basin, 1993+

Intrastate Locomotive	Air Basin	CARB Aromatic Volume Percent	EPA Aromatic Volume Percent	Nonroad Aromatic Volume Percent	Weighted Aromatic Volume Percent	PM Emission Reduction Percent
Class I Local/Switcher	SC	10	31	31	29.0	-0.9%
	SJV	10	31	31	25.2	-2.4%
	MD	10	31	31	31.0	0.0%
	BA	10	31	31	13.9	-7.2%
	SD	10	31	31	13.2	-7.5%
	SV	10	31	31	13.2	-7.5%
	SCC	10	31	31	13.2	-7.5%
Class III Local/Switcher	SC	10	31	31	31.0	0.0%
	SJV	10	31	31	18.6	-5.2%
	MD	10	31	31	10.0	-8.8%
	BA	10	31	31	10.0	-8.8%
	SD	10	31	31	10.0	-8.8%
	SV	10	31	31	10.0	-8.8%
	SCC	10	31	31	10.0	-8.8%
	NEP	10	31	31	26.6	-1.9%
	MC	10	31	31	31.0	0.0%
	NC	10	31	31	10.0	-8.8%
	NCC	10	31	31	10.0	-8.8%
Industrial/Military	SC	10	31	31	24.0	-3.0%
	SJV	10	31	31	24.0	-3.0%
	MD	10	31	31	24.0	-3.0%
	BA	10	31	31	24.0	-3.0%
	NEP	10	31	31	24.0	-3.0%
	SD	10	31	31	24.0	-3.0%
	SV	10	31	31	24.0	-3.0%
	SCC	10	31	31	24.0	-3.0%
Passenger	SC	10	31	31	10.8	-8.5%
	SJV	10	31	31	10.0	-8.8%
	BA	10	31	31	10.0	-8.8%
	SD	10	31	31	10.0	-8.8%
	SV	10	31	31	10.0	-8.8%
	SCC	10	31	31	12.1	-8.0%

Source : Fuel Estimate from http://www.arb.ca.gov/regact/carblohc/carblohc.htm

Sulfur

Currently, the baseline locomotive emissions inventory assumes an average fuel sulfur content of 2700 ppm. Industry has provided information on the sulfur content of the fuel that is currently being used by intrastate locomotives. Together with industry data and prior locomotive tests, staff believes a fuel correction factor should be incorporated into the model.

Table 24 shows the test data collected by the ARB, U.S. EPA, and others, where locomotive engines were tested on different fuel sulfur levels.

Table 24. Locomotive Engine Test with Different Sulfur Levels

Locomotive Engine	Fuel Properties Sulfur Content	Percent Change PM	Percent Change NOX	Percent Change CO	Percent Change HC	Source
EMD 12-645E3B	100/3300ppm	-0.29	-0.06	0.17	0.07	Fritz, 1991
GE DASH9-40C	330/3150ppm	-0.43	-0.07	-0.05	-0.18	Fritz (1995, EPA/SWRI)
MK 5000C	330/3150ppm	-0.71	-0.03	-0.03	-0.07	Fritz (1995, EPA/SWRI)
EMD 16-710G3B, SD70MAC	330/3150ppm	-0.38	-0.08	-0.30	-0.01	Fritz (1995, EPA/SWRI)
EMD SD70MAC	50/330ppm	-0.03	-0.04	0.07	0.01	Fritz (ARB/AAR, 2000)
EMD SD70MAC	50/4760ppm	-0.16	-0.06	0.08	0.03	Fritz (ARB/AAR, 2000)
EMD SD70MAC	330/4760ppm	-0.13	-0.03	0.01	0.01	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/330ppm	-0.03	-0.03	-0.01	-0.04	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/4760ppm	-0.39	-0.07	-0.02	0.02	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	330/4760ppm	-0.38	-0.04	-0.02	0.06	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	50/3190ppm	-0.27	-0.05	-0.03	0.01	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	330/3190ppm	-0.25	-0.02	-0.02	0.04	Fritz (ARB/AAR, 2000)
GE DASH9-44CW	3190/4760ppm	-0.17	-.02	0.00	0.02	Fritz (ARB/AAR, 2000)
Average		-0.28	-0.05	-0.01	0.00	

From the above table, staff concluded that HC and CO emissions are not affected by different sulfur levels in the fuel. From these tests, staff computed the changes in PM emissions associated with changes in sulfur level. Staff corrected the PM emissions to account for the aromatic differences because the test data were not tested at the same aromatic volume percent. Because the locomotive engine testing was performed at various fuel sulfur levels (some at 330 ppm vs. 3190 ppm and some at 50 ppm vs. 3190 ppm), staff cannot assume the average percent change in PM emission is characteristics over the whole range of sulfur levels. From previous studies that staff has analyzed, it is possible to generate estimates of the percent change at various sulfur levels and throttle positions. Locomotive engines have 8 throttle positions plus dynamic braking and idle. During idle, braking, and throttle positions 1 and 2, there are no significant differences in emissions attributable to sulfur level. For the GE 4-

stroke engine, effect of sulfur on PM for throttle positions 3 to 8 can be defined by using the following equations:

<u>Equations to correct for PM for GE (4-Stroke) engines</u>

Notch 8 : PM (g/bhp-hr) = 0.00001308 * (sulfur level,ppm) + 0.0967
Notch 7 : PM (g/bhp-hr) = 0.00001102 * (sulfur level,ppm) + 0.0845
Notch 6 : PM (g/bhp-hr) = 0.00000654 * (sulfur level,ppm) + 0.1037
Notch 5 : PM (g/bhp-hr) = 0.00000548 * (sulfur level,ppm) + 0.1320
Notch 4 : PM (g/bhp-hr) = 0.00000663 * (sulfur level,ppm) + 0.1513
Notch 3 : PM (g/bhp-hr) = 0.00000979 * (sulfur level,ppm) + 0.1565

For the EMD 2-stroke engine, throttle positions 3 to 8 can be defined by using the following equations:

<u>Equations to correct for PM for EMD (2-Stroke) engines</u>

Notch 8 : PM (g/bhp-hr) = 0.0000123 * (sulfur level,ppm) + 0.3563
Notch 7 : PM (g/bhp-hr) = 0.0000096 * (sulfur level,ppm) + 0.2840
Notch 6 : PM (g/bhp-hr) = 0.0000134 * (sulfur level,ppm) + 0.2843
Notch 5 : PM (g/bhp-hr) = 0.0000150 * (sulfur level,ppm) + 0.2572
Notch 4 : PM (g/bhp-hr) = 0.0000125 * (sulfur level,ppm) + 0.2629
Notch 3 : PM (g/bhp-hr) = 0.0000065 * (sulfur level,ppm) + 0.2635

Table 25. Examples of PM Reductions Due to Changes in Sulfur Level

Sulfur Level (ppm)		PM Reduction	PM Reduction	PM Reduction
From	To	2 Stroke	4 Stroke	Composite
3100	1900	4.1%	8.4%	5.2%
3100	1300	6.1%	12.6%	7.7%
1300	330	3.5%	7.9%	4.6%
1300	140	4.2%	9.5%	5.5%
140	15	1.8%	4.0%	2.4%

*composite is 75% 2 Stroke Engine and 25% 4 Stroke Engine

Data provided by industry show that when operating in California, the three main types of diesel fuel used in locomotive engines consists of CARB diesel, EPA On-Highway diesel fuel, and EPA Off-road or High Sulfur diesel fuel. Four-stroke engines and two-stroke engines show different characteristics with respect to sulfur content. From the BAH report, 4-stroke engines make up about 25%, and 2-stroke engines make up about 75% of the locomotive engine fleet. Combining industry data, 4-stroke/2-stroke engine percent change and fleet makeup, Table 26 shows the percent change in PM emissions by year for the line-haul segment of the fleet.

Table 26. PM Emission Percent Change of Line-Haul Due to Sulfur, Statewide

Calendar Year	CARB Sulfur Content	EPA On-Highway Sulfur Content	EPA Off-road Sulfur Content	Weighted Fuel Sulfur Content	4-Stroke Engines PM Percent Change	2-Stroke Engines PM Percent Change	Weighted PM Emission Percent Change
1992	3100	3100	3100	3100	0.03	0.01	0.015
1993	500	330	3100	2919	0.02	0.01	0.009
1994	150	330	3100	2740	0.01	0.00	0.003
1995	140	330	3100	2557	-0.01	0.00	-0.006
1996	140	330	3100	2377	-0.02	-0.01	-0.014
1997	140	330	3100	2196	-0.04	-0.02	-0.022
1998-2001	140	330	3100	1899	-0.06	-0.03	-0.035
2002-2006	140	330	3100	1312	-0.10	-0.05	-0.061
2007+	15	15	330	129	-0.19	-0.09	-0.113

Table 27 and Table 28 provide further details of weighted fuel sulfur level by air basin. Weighted sulfur levels vary significantly from one air basin to another.

Table 27. Class I Line Haul Weighted Fuel Sulfur by Air Basin

Interstate Locomotive	Air Basin	1998 Weighted Sulfur	2002-2006 Weighted Sulfur	2007+ Weighted Sulfur
		ppm	ppm	ppm
Class I Line Haul	SCC	1023	467	31
	MC	2333	1149	113
	MD	2352	1767	180
	NEP	2560	1632	166
	SC	1985	1472	145
	SF	1711	899	88
	SJV	1600	868	78
	SS	2425	1328	129
	SV	2473	1456	147

Table 28. Intrastate Locomotives Weighted Fuel Sulfur by Air Basin

Intrastate Locomotive	Air Basin	1993 Weighted Sulfur	1994-2006 Weighted Sulfur	2007+ Weighted Sulfur
		ppm	ppm	ppm
Class I Local/Switcher	SC	346	312	15
	SJV	377	278	15
	MD	330	330	15
	BA	468	175	15
	SD	475	169	15
	SV	475	169	15
	SCC	475	169	15
Class III Local/Switcher	SC	388	388	21
	SJV	1016	804	80
	MD	500	140	15
	BA	500	140	15
	SD	500	140	15
	SV	500	140	15
	SCC	500	140	15
	NEP	2628	2553	264
	MC	1573	1573	152
	NC	500	140	15
	NCC	500	140	15
Industrial/Military	SC	1340	1220	120
	SJV	1340	1220	120
	MD	1340	1220	120
	BA	1340	1220	120
	NEP	1340	1220	120
	SD	1340	1220	120
	SV	1340	1220	120
	SCC	1340	1220	120
Passenger	SC	493	147	15
	SJV	500	140	15
	BA	500	140	15
	SD	500	140	15
	SV	500	140	15
	SCC	483	159	15

Appendix B,C, and D contains the fuel correction factors for PM, NOx, and SOx emissions by air basin.

Revised Locomotive Emission Inventory

Tables 29-31 shows the revised locomotive emission inventory for calendar years 2000,2010 and 2020.

Table 29. 2000 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.61	18.21	113.03	2.68	6.22
Local/Short-Run	1.01	3.33	22.58	0.41	0.22
Mixed/Bulk	2.13	6.85	48.95	1.09	2.20
Passenger/Amtrak	0.53	1.01	12.21	0.29	0.05
Yard/Switcher	0.55	1.46	10.43	0.20	0.09
Total	9.83	30.86	207.20	4.67	8.78

Table 30. 2010 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.56	21.90	71.35	2.40	0.60
Local/Short-Run	0.77	2.99	12.03	0.30	0.01
Mixed/Bulk	2.11	8.24	29.46	0.99	0.19
Passenger/Amtrak	0.58	1.14	12.29	0.31	0.02
Yard/Switcher	0.47	1.29	6.78	0.17	0.01
Total	9.49	35.56	131.91	4.17	0.83

Table 31. 2020 Statewide Locomotive Emission Inventory, tons/day

TYPE	HC	CO	NOx	PM	SOx
Intermodal/Line-Haul	5.60	25.84	74.33	2.38	0.71
Local/Short-Run	0.67	2.99	11.17	0.26	0.01
Mixed/Bulk	2.13	9.72	31.14	0.98	0.23
Passenger/Amtrak	0.56	1.14	11.72	0.30	0.02
Yard/Switcher	0.44	1.29	6.22	0.16	0.01
Total	9.40	40.98	134.58	4.08	0.98

Appendix A

Methodology to Calculate Locomotive Inventory

Methodology

The methodology and assumptions used for estimating locomotive emissions consists of several steps taken from the Booz-Allen Hamilton's Locomotive Emission Study report (http://www.arb.ca.gov/app/library/libcc.php). First, emission factor data from various engine manufacturers such as EMD and General Electric (GE) must be gathered to calculate average emission factors for locomotives operated by the railroad companies. Second, train operations data, including throttle position profiles and time spent on various types of operations from different railroad companies needs to be estimated. Finally, the locomotive emission inventory can be calculated using train operations data, emission factors, and throttle position profiles.

Step 1 – Average Emission Factors

Engine emission factors are required for the different locomotive engines manufactured by the major locomotive suppliers EMD or GE. Emission factors are obtained from testing done by either the engine manufacturers or by Southwest Research Institute, a consulting company that has performed many tests on locomotive engines. Table A-1 lists the available emission factors.

Table A-1. Available Emission Factors for Different Locomotive Engines

Engine Manufacturer	Engine Model	Locomotive Model
EMD	12-567BC	SW10
EMD	12-645E	SW1500,MP15,GP15-1
EMD	16-567C	GP9
EMD	16-645E	GP38,GP38-2, GP28
EMD	12-645E3B	GP39-2
EMD	12-645E3	GP39-2, SD39
EMD	16-645E3	GP40, SD40, F40PH
EMD	16-645E3B	GP40-2, SD40-2, SDF40-2, F40PH
EMD	16-645F3	GP40X, GP50, SD45
EMD	16-645F3B	SD50
EMD	20-645E3	SD45,SD45-2, F45, FP45
EMD	16-710G3	GP60, SD60, SD60M
GE	127FDL2500	B23-7
GE	127FDL3000	SF30B
GE	167FDL3000	C30-7, SF30C
GE	167FDL4000	B40-8

Source: BAH report, 1992

Next, the locomotive roster from the largest railroad companies operating in the state were obtained. Table A-2 lists the locomotive roster for railroad companies in 1987.

Table A-2. Locomotive Roster 1987

					Type of Service		
Railroad Company	Engine Manufacturer	Engine Model	Horspower Rating	Units	Line Haul	Local	Yard/Switcher
ATSF	EMD	16-567BC	1500	211			X
ATSF	EMD	16-567C	1750	53			X
ATSF	EMD	16-567D2	2000	71		X	X
ATSF	EMD	16-645E	2000	69		X	X
ATSF	EMD	12-645E3	2300	62		X	
ATSF	EMD	12-645E3B	2300	60		X	
ATSF	EMD	16-645E3	2500	231	X	X	
ATSF	EMD	16-645E3	3000	18	X	X	
ATSF	EMD	16-645E3B	3000	203	X	X	
ATSF	EMD	16-645F3	3500	52	X		
ATSF	EMD	16-645F3B	3600	15	X		
ATSF	EMD	20-645E3	3600	243	X		
ATSF	EMD	16-710G3	3800	20	X		
ATSF	GE	GE-12	2350	60		X	
ATSF	GE	GE-12	3000	10	X	X	
ATSF	GE	GE-16	3000	226	X	X	

ATSF	GE	GE-16	3600	43	X		
ATSF	GE	GE-16	3900	3	X		
ATSF	GE	GE-16	4000	20	X		
Union Pacific	EMD	16-645BC	1200	56			X
Union Pacific	EMD	12-567A	1200	12			X
Union Pacific	EMD	12-645E	1500	281			X
Union Pacific	EMD	16-567CE	1500	35			X
Union Pacific	EMD	16-645E	2000	365		X	X
Union Pacific	EMD	12-645E3C	2300	24		X	
Union Pacific	EMD	16-567D3A	2500	16		X	
Union Pacific	EMD	16-645E3	3000	828	X	X	
Union Pacific	EMD	16-645E3B	3000	446	X	X	
Union Pacific	EMD	16-645F3	3500	36	X		
Union Pacific	EMD	16-645F3B	3600	60	X		
Union Pacific	EMD	16-710G3	3800	227	X		
Union Pacific	GE	GE-12	2300	106		X	
Union Pacific	GE	GE-12	3000	57	X	X	
Union Pacific	GE	GE-16	3000	156	X	X	
Union Pacific	GE	GE-16	3750	60	X		
Union Pacific	GE	GE-16	3800	256	X		
Southern Pacific	EMD	12-567C	1200	11			X
Southern Pacific	EMD	12-645E	1500	286			X
Southern Pacific	EMD	16-567BC	1500	37			X
Southern Pacific	EMD	16-567C	1750	326		X	
Southern Pacific	EMD	16-567D2	2000	145		X	
Southern Pacific	EMD	16-645E	2000	84		X	
Southern Pacific	EMD	12-645E3	2300	12		X	
Southern Pacific	EMD	16-645E3	2500	137	X	X	
Southern Pacific	EMD	16-645E3	3000	92	X		
Southern Pacific	EMD	16-645E3B	3000	353	X		
Southern Pacific	EMD	16-645F3	3500	4	X		
Southern Pacific	EMD	20-645E3	3600	425	X		
Southern Pacific	EMD	16-710G3	3800	65	X		
Southern Pacific	GE	GE-12	2300	15		X	
Southern Pacific	GE	GE-12	3000	107	X		
Southern Pacific	GE	GE-16	3600	20	X		
Southern Pacific	GE	GE-16	3900	92	X		

Source : BAH report, 1992

Using the available emission factors and the locomotive rosters, the average emission factors for each class of service can be calculated. Emission factors for models that were not available were assigned an emission factor based on horsepower rating and the number of cylinders from similar engine models.

Step 2 – Throttle Position Profiles and Train Operations Data

The railroad companies provided throttle position profiles. Locomotive engines operate at eight different constant loads and speeds called throttle notches. In addition, several other settings (idle and dynamic brake) are also common. For line haul and local operations, profiles were obtained from Train Performance Calculation (TPC) data and actual event recorder data, which are summarized in the BAH report.

For line haul operations, the data was modified to account for additional idle time between dispatch. Data supplied by Atchison, Topeka and Santa Fe (ATSF) indicates that the turnaround time for line haul locomotives in yards is approximately eight hours.

For local operations, several assumptions were used to develop throttle profiles. First, ten hours was used as an average hours per assignment. Second, the additional average idle time per day per locomotive was assumed to be ten hours.

The switch engine duty cycle is based upon actual tape data supplied by the ATSF railroad company on a switch engine that operated over a 2-day period. Yard engines are assumed to operate 350 days per year, with 2 weeks off for inspections and maintenance.

Train operations data provided by the railroad companies included :

Line Haul	**Local**	**Yard/Switcher**
Train type	Average trailing tons	Number of units assigned
Number of runs per year	Number of runs per year	Number of assignments
Average horsepower	Average horsepower	Average horsepower
Average units	Average units	
Origin/destination	Origin/destination	
Link miles		

Step 3 – Calculate Locomotive Emission Inventory

Emission inventories are calculated on a train-by-train basis using train operations data, average emission factor, and throttle position profiles.

Emission Inventory = Emission factor x average horsepower x time in notch per train x number of runs per year

Appendix B
PM Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	PM Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.991	0.982	0.973	0.964	0.955	0.937	0.931	0.925	0.919	0.913	0.913	0.913	0.913	0.913	0.883
	MC	1.000	0.998	0.996	0.994	0.992	0.990	0.987	0.971	0.955	0.939	0.923	0.923	0.923	0.923	0.923	0.867
	MD	1.000	0.998	0.995	0.993	0.991	0.988	0.984	0.978	0.973	0.967	0.962	0.962	0.962	0.962	0.962	0.884
	NEP	1.000	0.999	0.998	0.998	0.997	0.996	0.995	0.983	0.971	0.959	0.947	0.947	0.947	0.947	0.947	0.875
	SC	1.000	0.996	0.993	0.989	0.986	0.982	0.975	0.970	0.965	0.960	0.955	0.955	0.955	0.955	0.955	0.888
	SF	1.000	0.993	0.987	0.980	0.974	0.967	0.954	0.940	0.926	0.912	0.898	0.898	0.898	0.898	0.898	0.851
	SJV	1.000	0.993	0.986	0.979	0.972	0.965	0.952	0.944	0.937	0.930	0.923	0.923	0.923	0.923	0.923	0.878
	SS	1.000	0.999	0.997	0.996	0.995	0.993	0.991	0.980	0.970	0.959	0.949	0.949	0.949	0.949	0.949	0.887
	SV	1.000	0.993	0.986	0.979	0.972	0.965	0.952	0.948	0.945	0.942	0.939	0.939	0.939	0.939	0.939	0.873

Intrastate Loc	Air Basin	PM Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.890	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.865
	SJV	1.000	0.863	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.858	0.836
	MD	1.000	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.906	0.882
	BA	1.000	0.778	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.764	0.747
	SD	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
	SV	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
	SCC	1.000	0.772	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.758	0.741
Class III Loca	SC	1.000	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.909	0.882
	SJV	1.000	0.839	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.830	0.787
	MD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	BA	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SCC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	NEP	1.000	0.963	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.960	0.858
	MC	1.000	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.959	0.888
	NC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	NCC	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.722
Industrial/Milit	SC	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SJV	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	MD	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	BA	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	NEP	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SD	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SV	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
	SCC	1.000	0.894	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.889	0.831
Passenger	SC	1.000	0.754	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.739	0.723
	SJV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	BA	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SD	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SV	1.000	0.749	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.733	0.717
	SCC	1.000	0.764	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.749	0.733

PRELIMINARY DRAFT – DO NOT CITE OR QUOTE

Appendix C
NOx Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	NOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SF	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SS	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940

Intrastate Loc	Air Basin	NOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Class III Loca	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Industrial/Milit	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	MD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	NEP	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
Passenger	SC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SJV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	BA	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SD	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SV	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940
	SCC	1.000	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940	0.940

Appendix D
SOx Fuel Correction Factor by Air Basin

Interstate Loc	Air Basin	SOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Line H	SCC	1.000	0.896	0.793	0.689	0.586	0.482	0.379	0.327	0.276	0.225	0.173	0.173	0.173	0.173	0.173	0.011
	MC	1.000	0.977	0.955	0.932	0.909	0.887	0.864	0.755	0.645	0.535	0.426	0.426	0.426	0.426	0.426	0.042
	MD	1.000	0.979	0.957	0.936	0.914	0.893	0.871	0.817	0.763	0.709	0.654	0.654	0.654	0.654	0.654	0.067
	NEP	1.000	0.991	0.983	0.974	0.965	0.957	0.948	0.862	0.776	0.690	0.605	0.605	0.605	0.605	0.605	0.062
	SC	1.000	0.956	0.912	0.868	0.823	0.779	0.735	0.688	0.640	0.593	0.545	0.545	0.545	0.545	0.545	0.054
	SF	1.000	0.939	0.878	0.817	0.756	0.695	0.634	0.559	0.483	0.408	0.333	0.333	0.333	0.333	0.333	0.033
	SJV	1.000	0.932	0.864	0.796	0.728	0.660	0.593	0.525	0.457	0.389	0.322	0.322	0.322	0.322	0.322	0.029
	SS	1.000	0.983	0.966	0.949	0.932	0.915	0.898	0.797	0.695	0.594	0.492	0.492	0.492	0.492	0.492	0.048
	SV	1.000	0.986	0.972	0.958	0.944	0.930	0.916	0.822	0.728	0.634	0.539	0.539	0.539	0.539	0.539	0.054

Intrastate Loc	Air Basin	SOx Fuel Correction Factor															
		pre 1993	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007+
Class I Local/	SC	1.000	0.128	0.127	0.126	0.125	0.124	0.122	0.121	0.120	0.119	0.118	0.117	0.115	0.115	0.115	0.006
	SJV	1.000	0.139	0.136	0.133	0.130	0.126	0.123	0.120	0.116	0.113	0.110	0.106	0.103	0.103	0.103	0.006
	MD	1.000	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.122	0.006
	BA	1.000	0.173	0.164	0.154	0.144	0.134	0.124	0.114	0.104	0.095	0.085	0.075	0.065	0.065	0.065	0.006
	SD	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
	SV	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
	SCC	1.000	0.176	0.165	0.155	0.145	0.135	0.124	0.114	0.104	0.093	0.083	0.073	0.062	0.062	0.062	0.006
Class III Loca	SC	1.000	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.144	0.008
	SJV	1.000	0.376	0.369	0.362	0.355	0.348	0.341	0.333	0.326	0.319	0.312	0.305	0.298	0.298	0.298	0.029
	MD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	BA	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SCC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	NEP	1.000	0.973	0.971	0.968	0.966	0.963	0.961	0.958	0.956	0.953	0.951	0.948	0.946	0.946	0.946	0.098
	MC	1.000	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.583	0.056
	NC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	NCC	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
Industrial/Milit	SC	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SJV	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	MD	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	BA	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	NEP	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SD	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SV	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
	SCC	1.000	0.496	0.492	0.488	0.484	0.480	0.476	0.472	0.468	0.464	0.460	0.456	0.452	0.452	0.452	0.044
Passenger	SC	1.000	0.183	0.171	0.159	0.148	0.136	0.124	0.113	0.101	0.090	0.078	0.066	0.055	0.055	0.055	0.006
	SJV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	BA	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SD	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SV	1.000	0.185	0.173	0.161	0.149	0.137	0.125	0.112	0.100	0.088	0.076	0.064	0.052	0.052	0.052	0.006
	SCC	1.000	0.179	0.168	0.157	0.146	0.135	0.124	0.113	0.103	0.092	0.081	0.070	0.059	0.059	0.059	0.006

APPENDIX B

EMISSION FACTOR DERIVATION AND
EMFAC-WD 2006 OUTPUT FOR ON-ROAD DIESEL-FUELED TRUCKS

Emission Factors for On-Road Diesel-Fueled Trucks
Commerce Rail Yard, Los Angeles, CA

Running Exhaust Emissions

Equipment Type	Equip. ID	Make	Model	Model Year	Vehicle Class	Emission Factors (g/mi)[1]				
						ROG	CO	NOx	DPM	SOx
Pickup	ITS-950	Ford	F150	1996	LDT	0.11	1.11	1.62	0.07	0.04
Pickup	ITS-2027	Ford	F250	2000	MDV	0.13	1.13	0.48	0.13	0.00
Pickup	ITS-2018	Ford	F250	2002	MDV	0.10	1.16	1.64	0.10	0.00
Pickup	ITS-2048	Ford	F250	2002	MDV	0.10	1.16	1.64	0.10	0.00
Pickup	UP-19939	Ford	F350	2002	LHDT1	0.35	1.76	6.73	0.09	0.05
Pickup	ITS-2145	Ford	F350	2002	LHDT1	0.35	1.76	6.73	0.09	0.05
Pickup	ITS-2141	Ford	F350	2005	LHDT1	0.22	1.45	5.73	0.06	0.06
Total										

Idling Exhaust Emissions

Equipment Type	Equip. ID	Make	Model	Model Year	Vehicle Class	Emission Factors (g/hr)[1]				
						ROG	CO	NOx	DPM	SOx
Pickup	ITS-950	Ford	F150	1996	LDT	0.000	0.000	0.000	0.000	0.000
Pickup	ITS-2027	Ford	F250	2000	MDV	0.000	0.000	0.000	0.000	0.000
Pickup	ITS-2018	Ford	F250	2002	MDV	0.000	0.000	0.000	0.000	0.000
Pickup	ITS-2048	Ford	F250	2002	MDV	0.000	0.000	0.000	0.000	0.000
Pickup	UP-19939	Ford	F350	2002	LHDT1	3.173	26.300	75.051	0.753	0.341
Pickup	ITS-2145	Ford	F350	2002	LHDT1	3.173	26.300	75.051	0.753	0.341
Pickup	ITS-2141	Ford	F350	2005	LHDT1	3.173	26.300	75.051	0.753	0.341
Total										

Notes:

1. Emission factors calculated using the EMFAC-WD 2006 model with the BURDEN output option.
2. Idling exhaust emission factors for LHDT1 vehicles calculated using the EMFAC-WD 2006 model with the EMFAC output option.

Title : South Central Coast Air Basin Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+
Run Date : 2006/08/24 14:41:20
Scen Year: 2005 -- Model year 1996 selected
Season : Annual
Area : Statewide totals Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	LDT1-DSL
Vehicles	8183
VMT/1000	246
Trips	51957
Reactive Organic Gas Emissions	
Run Exh	0.03
Idle Exh	0
Start Ex	0

Total Ex	0.03
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.03
Carbon Monoxide Emissions	
Run Exh	0.3
Idle Exh	0
Start Ex	0

Total Ex	0.3
Oxides of Nitrogen Emissions	
Run Exh	0.44
Idle Exh	0
Start Ex	0

Total Ex	0.44
Carbon Dioxide Emissions (000)	
Run Exh	0.09
Idle Exh	0
Start Ex	0

Total Ex	0.09
PM10 Emissions	
Run Exh	0.02
Idle Exh	0
Start Ex	0

Total Ex	0.02
TireWear	0
BrakeWr	0

Total	0.02
Lead	0
SOx	0.01
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	8.44

Title : Statewide totals Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg
Run Date : 2006/08/24 15:08:57
Scen Year: 2005 -- Model year 2000 selected
Season : Annual
Area : Statewide totals Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	MDV-DSL
Vehicles	2037
VMT/1000	72
Trips	13177
Reactive Organic Gas Emissions	
Run Exh	0.01
Idle Exh	0
Start Ex	0

Total Ex	0.01
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.01
Carbon Monoxide Emissions	
Run Exh	0.09
Idle Exh	0
Start Ex	0

Total Ex	0.09
Oxides of Nitrogen Emissions	
Run Exh	0.13
Idle Exh	0
Start Ex	0

Total Ex	0.13
Carbon Dioxide Emissions (000)	
Run Exh	0.03
Idle Exh	0
Start Ex	0

Total Ex	0.03
PM10 Emissions	
Run Exh	0.01
Idle Exh	0
Start Ex	0

Total Ex	0.01
TireWear	0
BrakeWr	0

Total	0.01
Lead	0
SOx	0
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	2.47

Title : Statewide totals Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg
Run Date : 2006/08/24 15:29:06
Scen Year: 2005 -- Model year 2002 selected
Season : Annual
Area : Statewide totals Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	MDV-DSL	LHDT1-DSL
Vehicles	2421	8859
VMT/1000	94	391
Trips	15738	111435
Reactive Organic Gas Emissions		
Run Exh	0.01	0.15
Idle Exh	0	0
Start Ex	0	0
	-------	-------
Total Ex	0.01	0.15
Diurnal	0	0
Hot Soak	0	0
Running	0	0
Resting	0	0
	-------	-------
Total	0.01	0.15
Carbon Monoxide Emissions		
Run Exh	0.12	0.76
Idle Exh	0	0.01
Start Ex	0	0
	-------	-------
Total Ex	0.12	0.77
Oxides of Nitrogen Emissions		
Run Exh	0.17	2.9
Idle Exh	0	0.03
Start Ex	0	0
	-------	-------
Total Ex	0.17	2.92
Carbon Dioxide Emissions (000)		
Run Exh	0.04	0.22
Idle Exh	0	0
Start Ex	0	0
	-------	-------
Total Ex	0.04	0.23
PM10 Emissions		
Run Exh	0.01	0.04
Idle Exh	0	0
Start Ex	0	0
	-------	-------
Total Ex	0.01	0.04
TireWear	0	0.01
BrakeWr	0	0.01
	-------	-------
Total	0.01	0.05
Lead	0	0
SOx	0	0.02
Fuel Consumption (000 gallons)		
Gasoline	0	0
Diesel	3.22	20.27

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Po
Run Date : 2006/10/09 09:24:19
Scen Year: 2005 -- Model year 2002 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 2002 to 2002 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Los Angeles County Average

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	23.103	3.173	20.486

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	141.992	26.3	126.798

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	1.561	75.051	11.212

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0.049	0.341	0.087

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0.753	0.099

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Title   : Los Angeles County Avg January CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDl
Run Date : 2006/09/25 11:50:22
Scen Year: 2005 -- Model year 2005 selected
Season   : January
Area   : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	LHDT1-DSL
Vehicles	2196
VMT/1000	163
Trips	27623
Reactive Organic Gas Emissions	
Run Exh	0.04
Idle Exh	0
Start Ex	0

Total Ex	0.04
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	0.04
Carbon Monoxide Emissions	
Run Exh	0.26
Idle Exh	0
Start Ex	0

Total Ex	0.26
Oxides of Nitrogen Emissions	
Run Exh	1.03
Idle Exh	0.01
Start Ex	0

Total Ex	1.04
Carbon Dioxide Emissions (000)	
Run Exh	0.09
Idle Exh	0
Start Ex	0

Total Ex	0.09
PM10 Emissions	
Run Exh	0.01
Idle Exh	0
Start Ex	0

Total Ex	0.01
TireWear	0
BrakeWr	0

Total	0.02
Lead	0
SOx	0.01
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	8.43

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Po
Run Date : 2006/10/09 09:24:43
Scen Year: 2005 -- Model year 2005 selected
Season : Annual
Area : Los Angeles
****
Year: 2005 -- Model Years 2005 to 2005 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Los Angeles County Average

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	27.137	3.173	18.629

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	155.23	26.3	109.457

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	1.79	75.051	27.799

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0.049	0.341	0.153

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0.753	0.267

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	LHD1 NCAT	LHD1 CAT	LHD1 DSL	LHD1 ALL
0	0	0	0	0

APPENDIX C

EMISSION FACTOR DERIVATION AND EMFAC-WD 2006 OUTPUT FOR HHD DIESEL-FUELED TRUCKS

Emission Factors for Intermodal HHD Diesel-Fueled Truck Traffic
Commerce Rail Yard, Los Angeles, CA

Running Exhaust Emissions

Emission Factors (g/mi)				
ROG	CO	NOx	DPM	SOx
5.73	15.40	27.41	2.27	0.24

Idling Exhaust Emissions

Emission Factors (g/hr)				
ROG	CO	NOx	PM10	SOx
16.163	52.988	100.382	2.845	0.550

Notes:
1. Running exhaust emission factors from EMFAC-WD 2006 using the BURDEN output option.
2. Idling exhaust emission factors from EMFAC-WD 2006 using the EMFAC output option.
3. Emission factor calculations assumed an average speed of 15 mph.

Summary of Intermodal Traffic Gate Counts
Commerce Rail Yard, Los Angeles, CA

Month	In-Gate Total [1]	Out-Gate Total [1]	In & Out Bobtails [2]	In & Out Total
Jan	8,633	8,326	4,240	21,199
Feb	13,105	8,554	5,415	27,074
Mar	15,190	13,006	7,049	35,245
Apr	15,523	11,808	6,833	34,164
May	16,027	12,247	7,069	35,343
June	17,207	13,271	7,620	38,098
July	15,862	11,552	6,854	34,268
Aug	13,871	10,814	6,171	30,856
Sept	15,132	7,364	5,624	28,120
Oct	16,195	8,914	6,277	31,386
Nov	15,626	9,609	6,309	31,544
Dec	12,561	9,151	5,428	27,140
Totals	174,932	124,616	74,887	**374,435**

Notes:
1. Provided by UPRR. (In&Out Gate Box Balance.pdf Reports).
2. Personal communication with Tony Jardino and Ben Shelton of UPRR.

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +
Run Date : 2006/08/22 16:01:02
Scen Year: 2005 -- All model years in the range 1965 to 2005 selected
Season : Annual
Area : Los Angeles County Average
I/M Stat : Enhanced Interim (2005) -- Using I/M schedule for area 59 Los Angeles (SC)
Emissions: Tons Per Day
****

	HHDT-DSL
Vehicles	23847
VMT/1000	4179
Trips	120678
Reactive Organic Gas Emissions	
Run Exh	26.4
Idle Exh	0.72
Start Ex	0

Total Ex	27.12
Diurnal	0
Hot Soak	0
Running	0
Resting	0

Total	27.12
Carbon Monoxide Emissions	
Run Exh	70.96
Idle Exh	2.35
Start Ex	0

Total Ex	73.31
Oxides of Nitrogen Emissions	
Run Exh	126.26
Idle Exh	4.45
Start Ex	0

Total Ex	130.71
Carbon Dioxide Emissions (000)	
Run Exh	13.21
Idle Exh	0.29
Start Ex	0

Total Ex	13.5
PM10 Emissions	
Run Exh	10.47
Idle Exh	0.13
Start Ex	0

Total Ex	10.6
TireWear	0.17
BrakeWr	0.13

Total	10.89
Lead	0
SOx	1.12
Fuel Consumption (000 gallons)	
Gasoline	0
Diesel	1214.88

Title : Los Angeles County Avg Annual CYr 2005 Default Title
Version : Emfac working draft V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg +FCF2+Pop
Run Date : 2006/12/03 10:21:20
Scen Year: 2005 -- All model years in the range 1965 to 2005 selected
Season : Annual
Area : Los Angeles
****

Year: 2005 -- Model Years 1965 to 2005 Inclusive --
Emfac working draft Emission Factors: V2.23.7.60616 Sp: 2.20.8+FCF+IM+Bugs+BER+Accr+IMDlg

County Average Los Angeles

Table 1: Running Exhaust Emissions (grams/mile; grams/idle-hour)

Pollutant Name: Reactive Org Gases Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	16.163	15.188

Pollutant Name: Carbon Monoxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	52.988	49.792

Pollutant Name: Oxides of Nitrogen Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	100.382	94.327

Pollutant Name: Sulfur Dioxide Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0.55	0.517

Pollutant Name: PM10 Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	2.845	2.674

Pollutant Name: PM10 - Tire Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

Pollutant Name: PM10 - Break Wear Temperature: 65F Relative Humidity: 60%

Speed MPH	HHD NCAT	HHD CAT	HHD DSL	HHD ALL
0	0	0	0	0

APPENDIX D

EMISSION FACTOR DERIVATION AND OFFROAD2006 OUTPUT FOR CARGO HANDLING EQUIPMENT

Emission Factors for Diesel-Fueled Cargo Handling Equipment
Commerce Rail Yard, Los Angeles, CA

Equipment Type	Equipment ID	Make	Model	Year	Load Factor	Emission Factors (g/bhp-hr)				
						HC	CO	NOx	DPM	SOx
Chassis Stacker	69303	Taylor	TCS90	1993	0.30	0.53	2.84	7.94	0.33	7.02
Chassis Stacker	69515	Taylor	TCS90	1995	0.30	0.53	2.82	7.89	0.32	7.02
RTG	98716	Mi Jack	1000R	1987	0.43	0.75	4.64	11.36	0.54	7.02
RTG	99119	Mi Jack	1000R	1991	0.43	0.58	2.98	8.26	0.36	7.02
RTG	99636	Mi Jack	850R	1996	0.43	0.26	0.98	6.27	0.15	7.02
RTG	99740	Mi Jack	850R	1997	0.43	0.26	0.98	6.24	0.14	7.02
RTG	90082	Mi Jack	1000R	2000	0.43	0.25	0.96	6.13	0.14	7.02
RTG	90393	Taylor	9040	2003	0.43	0.09	0.94	4.14	0.10	7.02
RTG	90402	Mi Jack	1000RC	2004	0.43	0.09	0.93	4.11	0.09	7.02
Top Pick	88646	Raygo	CH70	1986	0.59	0.79	4.78	11.42	0.57	7.02
Fork Lift	105	Lull	John Deere	1975	0.30	0.88	4.95	12.37	0.55	7.02
Yard Hostler	199510	Capacity	TJ5100	1999	0.55	0.52	2.79	6.74	0.34	7.02
Yard Hostler	199519	Capacity	TJ5100	1999	0.55	0.52	2.79	6.74	0.34	7.02
Yard Hostler	100560	Capacity	TJ5100	2000	0.55	0.52	2.78	6.71	0.34	7.02
Yard Hostler	101619	Capacity	TJ5100	2001	0.55	0.51	2.77	6.68	0.33	7.02
Yard Hostler	102733	Capacity	TJ5100	2002	0.55	0.51	2.75	6.66	0.33	7.02
Yard Hostler	103770	Capacity	TJ5100	2003	0.55	0.24	2.74	5.05	0.21	7.02
Yard Hostler	104778	Capacity	TJ5100	2004	0.55	0.16	2.73	4.51	0.16	7.02
Yard Hostler	106916	Capacity	TJ5100	2006	0.55	0.12	2.70	4.21	0.13	7.02

Notes:
1. Emission factors from CARB's Cargo Handling Equipment Emission Calculation Spreadsheet.

													If no emission control leave blank					
Cal Year	Yard	Equipment Type	Code	Useful Life (hours)	Model Year	Age (years)	Population	HP	HP Bin	Yearly Operational Hrs	Cummulative Hours	Emission Control Factor? (y/n)	Emission Control	Load Factor	HPMY	HC EF	Emission Control HC EF	HC dr
2005	*(Example Calculation)*	*Yard Tractor onroad*	*9*	*8800*	*1985*	*21*	*2*	*500*	*500*	*1100*	*23100*	*n*		*0.65*	*5001985*	*1.30E+00*	*0.00E+00*	0.000065
2005	Commerce	Forklift	3	23040	1993	13	2	150	175	1152	14976	n		0.30	1751993	6.80E-01	0.00E+00	0.000008
2005	Commerce	Forklift	3	23040	1995	11	1	150	175	1152	12672	n		0.30	1751995	6.80E-01	0.00E+00	0.000008
2005	Commerce	Crane	1	44064	1987	19	2	300	500	2448	46512	n		0.43	5001987	8.40E-01	0.00E+00	0.000008
2005	Commerce	Crane	1	44064	1991	15	1	300	500	2448	36720	n		0.43	5001991	6.80E-01	0.00E+00	0.000007
2005	Commerce	Crane	1	44064	1996	10	1	300	500	2448	24480	n		0.43	5001996	3.20E-01	0.00E+00	0.000003
2005	Commerce	Crane	1	44064	1997	9	1	300	500	2448	22032	n		0.43	5001997	3.20E-01	0.00E+00	0.000003
2005	Commerce	Crane	1	44064	2000	6	1	300	500	2448	14688	n		0.43	5002000	3.20E-01	0.00E+00	0.000003
2005	Commerce	Crane	1	44064	2003	3	2	300	500	2448	7344	n		0.43	5002003	1.20E-01	0.00E+00	0.000001
2005	Commerce	Crane	1	44064	2004	2	1	300	500	2448	4896	n		0.43	5002004	1.20E-01	0.00E+00	0.000001
2005	Commerce	Material Handling Equip	4	1080	1986	20	1	250	250	60	1200	n		0.59	2501986	8.80E-01	0.00E+00	0.000359
2005	Commerce	Forklift	3	7300	1975	31	1	150	175	365	11315	n		0.30	1751975	1.00E+00	0.00E+00	0.000038
2005	Commerce	Yard Tractor offroad	8	74880	1999	7	2	150	175	4680	32760	n		0.55	1751999	6.80E-01	0.00E+00	0.000003
2005	Commerce	Yard Tractor offroad	8	74880	1999	7	1	150	175	4680	32760	n		0.55	1751999	6.80E-01	0.00E+00	0.000003
2005	Commerce	Yard Tractor offroad	8	74880	2000	6	2	150	175	4680	28080	n		0.55	1752000	6.80E-01	0.00E+00	0.000003
2005	Commerce	Yard Tractor offroad	8	74880	2001	5	6	150	175	4680	23400	n		0.55	1752001	6.80E-01	0.00E+00	0.000003
2005	Commerce	Yard Tractor offroad	8	74880	2002	4	3	150	175	4680	18720	n		0.55	1752002	6.80E-01	0.00E+00	0.000003
2005	Commerce	Yard Tractor offroad	8	74880	2003	3	1	150	175	4680	14040	n		0.55	1752003	3.30E-01	0.00E+00	0.000001
2005	Commerce	Yard Tractor offroad	8	74880	2004	2	8	150	175	4680	9360	n		0.55	1752004	2.20E-01	0.00E+00	0.000001
2005	Commerce	Yard Tractor offroad	8	74880	2006	0	3	150	175	4680	0	n		0.55	1752006	1.60E-01	0.00E+00	0.000001
2005	Commerce	Yard Tractor offroad	8	74880	2000	6	3	150	175	4680	28080	n		0.55	1752000	6.80E-01	0.00E+00	0.000003
2005	Commerce	Crane	1	2700	2000	6	1	200	250	150	900	n		0.43	2502000	3.20E-01	0.00E+00	0.000052
2005	Commerce	Forklift	3	7300	1995	11	3	60	120	365	4015	n		0.30	1201995	9.90E-01	0.00E+00	0.000038
2005	Commerce	Forklift	3	7300	1995	11	1	240	250	365	4015	n		0.30	2501995	6.80E-01	0.00E+00	0.000041
2005	Commerce	Forklift	3	7300	1989	17	1	66	120	365	6205	n		0.30	1201989	9.90E-01	0.00E+00	0.000038
2005	Commerce	Crane	1	13140	1990	16	1	115	120	730	11680	n		0.43	1201990	9.90E-01	0.00E+00	0.000021

FCF HC	CO EF	Emission Control CO EF	CO dr	NOX EF	Emission Control NOX EF	NOX dr	FCF NOX	PM EF	Emission Control PM EF	PM dr	FCF PM	SOX EF	Final EF_HC	Final EF_CO	Final EF_NOX	Final EF_SOX	Final EF_PM	TOG	ROG
0.720000	***1.55E+01***	***0.00E+00***	***0.000440***	***6.00E+00***	***0.00E+00***	***0.000143***	***0.930000***	***6.00E-01***	***0.00E+00***	***0.000046***	***0.750000***	***5.97E-02***	***2.02E+00***	***2.57E+01***	***8.66E+00***	***5.97E-02***	***1.24E+00***	***2.29E+00***	***2.01E+00***
0.720000	2.70E+00	0.00E+00	0.000019	8.17E+00	0.00E+00	0.000050	0.930000	3.80E-01	0.00E+00	0.000007	0.750000	5.97E-02	5.79E-01	2.98E+00	8.29E+00	5.97E-02	3.67E-01	9.52E-02	8.36E-02
0.720000	2.70E+00	0.00E+00	0.000019	8.17E+00	0.00E+00	0.000050	0.930000	3.80E-01	0.00E+00	0.000007	0.750000	5.97E-02	5.65E-01	2.94E+00	8.18E+00	5.97E-02	3.54E-01	4.65E-02	4.08E-02
0.720000	4.10E+00	0.00E+00	0.000023	1.10E+01	0.00E+00	0.000052	0.930000	5.30E-01	0.00E+00	0.000008	0.750000	5.21E-02	8.86E-01	5.18E+00	1.25E+01	5.21E-02	6.79E-01	8.87E-01	7.79E-01
0.720000	2.70E+00	0.00E+00	0.000015	8.17E+00	0.00E+00	0.000039	0.930000	3.80E-01	0.00E+00	0.000006	0.750000	5.21E-02	6.69E-01	3.26E+00	8.93E+00	5.21E-02	4.44E-01	3.35E-01	2.94E-01
0.720000	9.20E-01	0.00E+00	0.000005	6.25E+00	0.00E+00	0.000030	0.948000	1.50E-01	0.00E+00	0.000002	0.822000	5.21E-02	2.87E-01	1.05E+00	6.62E+00	5.21E-02	1.69E-01	1.44E-01	1.26E-01
0.720000	9.20E-01	0.00E+00	0.000005	6.25E+00	0.00E+00	0.000030	0.948000	1.50E-01	0.00E+00	0.000002	0.822000	5.21E-02	2.81E-01	1.04E+00	6.55E+00	5.21E-02	1.65E-01	1.41E-01	1.24E-01
0.720000	9.20E-01	0.00E+00	0.000005	6.25E+00	0.00E+00	0.000030	0.948000	1.50E-01	0.00E+00	0.000002	0.822000	5.21E-02	2.64E-01	9.97E-01	6.34E+00	5.21E-02	1.51E-01	1.32E-01	1.16E-01
0.720000	9.20E-01	0.00E+00	0.000005	4.29E+00	0.00E+00	0.000020	0.948000	1.10E-01	0.00E+00	0.000002	0.822000	5.21E-02	9.27E-02	9.58E-01	4.21E+00	5.21E-02	1.01E-01	9.29E-02	8.16E-02
0.720000	9.20E-01	0.00E+00	0.000005	4.29E+00	0.00E+00	0.000020	0.948000	1.10E-01	0.00E+00	0.000002	0.822000	5.21E-02	9.06E-02	9.46E-01	4.16E+00	5.21E-02	9.72E-02	4.54E-02	3.99E-02
0.720000	4.20E+00	0.00E+00	0.000972	1.10E+01	0.00E+00	0.002139	0.930000	5.50E-01	0.00E+00	0.000341	0.750000	5.97E-02	9.43E-01	5.37E+00	1.26E+01	5.97E-02	7.20E-01	1.32E-02	1.16E-02
0.720000	4.40E+00	0.00E+00	0.000096	1.20E+01	0.00E+00	0.000230	0.930000	5.50E-01	0.00E+00	0.000033	0.750000	5.97E-02	1.03E+00	5.49E+00	1.36E+01	5.97E-02	6.94E-01	2.69E-02	2.36E-02
0.720000	2.70E+00	0.00E+00	0.000006	6.90E+00	0.00E+00	0.000013	0.948000	3.80E-01	0.00E+00	0.000002	0.822000	5.97E-02	5.50E-01	2.89E+00	6.94E+00	5.97E-02	3.72E-01	6.73E-01	5.91E-01
0.720000	2.70E+00	0.00E+00	0.000006	6.90E+00	0.00E+00	0.000013	0.948000	3.80E-01	0.00E+00	0.000002	0.822000	5.97E-02	5.50E-01	2.89E+00	6.94E+00	5.97E-02	3.72E-01	3.37E-01	2.96E-01
0.720000	2.70E+00	0.00E+00	0.000006	6.90E+00	0.00E+00	0.000013	0.948000	3.80E-01	0.00E+00	0.000002	0.822000	5.97E-02	5.41E-01	2.86E+00	6.88E+00	5.97E-02	3.64E-01	6.63E-01	5.82E-01
0.720000	2.70E+00	0.00E+00	0.000006	6.90E+00	0.00E+00	0.000013	0.948000	3.80E-01	0.00E+00	0.000002	0.822000	5.97E-02	5.32E-01	2.84E+00	6.83E+00	5.97E-02	3.55E-01	1.96E+00	1.72E+00
0.720000	2.70E+00	0.00E+00	0.000006	6.90E+00	0.00E+00	0.000013	0.948000	3.80E-01	0.00E+00	0.000002	0.822000	5.97E-02	5.24E-01	2.81E+00	6.77E+00	5.97E-02	3.47E-01	9.62E-01	8.45E-01
0.720000	2.70E+00	0.00E+00	0.000006	5.26E+00	0.00E+00	0.000010	0.948000	2.40E-01	0.00E+00	0.000001	0.822000	5.97E-02	2.50E-01	2.78E+00	5.12E+00	5.97E-02	2.14E-01	1.53E-01	1.35E-01
0.720000	2.70E+00	0.00E+00	0.000006	4.72E+00	0.00E+00	0.000009	0.948000	1.90E-01	0.00E+00	0.000001	0.822000	5.97E-02	1.64E-01	2.75E+00	4.55E+00	5.97E-02	1.65E-01	8.03E-01	7.06E-01
0.720000	2.70E+00	0.00E+00	0.000006	4.44E+00	0.00E+00	0.000008	0.948000	1.60E-01	0.00E+00	0.000001	0.822000	5.97E-02	1.15E-01	2.70E+00	4.21E+00	5.97E-02	1.32E-01	2.12E-01	1.86E-01
0.720000	2.70E+00	0.00E+00	0.000006	6.90E+00	0.00E+00	0.000013	0.948000	3.80E-01	0.00E+00	0.000002	0.822000	5.97E-02	5.41E-01	2.86E+00	6.88E+00	5.97E-02	3.64E-01	9.94E-01	8.73E-01
0.720000	9.20E-01	0.00E+00	0.000085	6.25E+00	0.00E+00	0.000486	0.948000	1.50E-01	0.00E+00	0.000037	0.822000	5.97E-02	2.64E-01	9.97E-01	6.34E+00	5.97E-02	1.51E-01	5.40E-03	4.75E-03
0.720000	3.49E+00	0.00E+00	0.000076	8.75E+00	0.00E+00	0.000168	0.930000	6.90E-01	0.00E+00	0.000042	0.750000	6.23E-02	8.23E-01	3.80E+00	8.76E+00	6.23E-02	6.43E-01	2.57E-02	2.26E-02
0.720000	2.70E+00	0.00E+00	0.000092	8.17E+00	0.00E+00	0.000235	0.930000	3.80E-01	0.00E+00	0.000035	0.750000	5.97E-02	6.08E-01	3.07E+00	8.48E+00	5.97E-02	3.90E-01	2.53E-02	2.23E-02
0.720000	3.49E+00	0.00E+00	0.000076	8.75E+00	0.00E+00	0.000168	0.930000	6.90E-01	0.00E+00	0.000042	0.750000	6.23E-02	8.82E-01	3.96E+00	9.11E+00	6.23E-02	7.11E-01	1.01E-02	8.89E-03
0.720000	3.49E+00	0.00E+00	0.000042	8.75E+00	0.00E+00	0.000093	0.930000	6.90E-01	0.00E+00	0.000023	0.750000	6.23E-02	8.90E-01	3.99E+00	9.15E+00	6.23E-02	7.20E-01	5.10E-02	4.48E-02

Emissions (tons/year)						Emissions (tons/day)							
CO	NOX	SOX	PM	PM10	PM2.5	TOG	ROG	CO	NOX	SOX	PM	PM10	PM2.5
2.02E+01	***6.82E+00***	***4.70E-02***	***9.78E-01***	***9.78E-01***	***8.99E-01***	***6.27E-03***	***5.50E-03***	***5.54E-02***	***1.87E-02***	***1.29E-04***	***2.68E-03***	***2.68E-03***	***2.46E-03***
3.40E-01	9.47E-01	6.82E-03	4.18E-02	4.18E-02	3.85E-02	2.61E-04	2.29E-04	9.33E-04	2.59E-03	1.87E-05	1.15E-04	1.15E-04	1.05E-04
1.68E-01	4.67E-01	3.41E-03	2.02E-02	2.02E-02	1.86E-02	1.27E-04	1.12E-04	4.59E-04	1.28E-03	9.35E-06	5.54E-05	5.54E-05	5.09E-05
3.60E+00	8.69E+00	3.63E-02	4.72E-01	4.72E-01	4.34E-01	2.43E-03	2.14E-03	9.88E-03	2.38E-02	9.93E-05	1.29E-03	1.29E-03	1.19E-03
1.13E+00	3.10E+00	1.81E-02	1.54E-01	1.54E-01	1.42E-01	9.18E-04	8.07E-04	3.11E-03	8.51E-03	4.97E-05	4.23E-04	4.23E-04	3.89E-04
3.64E-01	2.30E+00	1.81E-02	5.88E-02	5.88E-02	5.41E-02	3.93E-04	3.46E-04	9.98E-04	6.30E-03	4.97E-05	1.61E-04	1.61E-04	1.48E-04
3.60E-01	2.28E+00	1.81E-02	5.72E-02	5.72E-02	5.27E-02	3.86E-04	3.39E-04	9.86E-04	6.24E-03	4.97E-05	1.57E-04	1.57E-04	1.44E-04
3.47E-01	2.20E+00	1.81E-02	5.25E-02	5.25E-02	4.83E-02	3.62E-04	3.18E-04	9.50E-04	6.04E-03	4.97E-05	1.44E-04	1.44E-04	1.32E-04
6.67E-01	2.93E+00	3.63E-02	6.99E-02	6.99E-02	6.43E-02	2.54E-04	2.24E-04	1.83E-03	8.02E-03	9.93E-05	1.92E-04	1.92E-04	1.76E-04
3.29E-01	1.45E+00	1.81E-02	3.38E-02	3.38E-02	3.11E-02	1.24E-04	1.09E-04	9.01E-04	3.97E-03	4.97E-05	9.26E-05	9.26E-05	8.52E-05
5.23E-02	1.23E-01	5.82E-04	7.01E-03	7.01E-03	6.45E-03	3.63E-05	3.19E-05	1.43E-04	3.37E-04	1.60E-06	1.92E-05	1.92E-05	1.77E-05
9.93E-02	2.46E-01	1.08E-03	1.26E-02	1.26E-02	1.15E-02	7.37E-05	6.47E-05	2.72E-04	6.73E-04	2.96E-06	3.44E-05	3.44E-05	3.16E-05
2.46E+00	5.90E+00	5.08E-02	3.17E-01	3.17E-01	2.91E-01	1.84E-03	1.62E-03	6.73E-03	1.62E-02	1.39E-04	8.68E-04	8.68E-04	7.98E-04
1.23E+00	2.95E+00	2.54E-02	1.58E-01	1.58E-01	1.46E-01	9.22E-04	8.10E-04	3.37E-03	8.09E-03	6.96E-05	4.34E-04	4.34E-04	3.99E-04
2.43E+00	5.85E+00	5.08E-02	3.09E-01	3.09E-01	2.85E-01	1.82E-03	1.59E-03	6.67E-03	1.60E-02	1.39E-04	8.48E-04	8.48E-04	7.80E-04
7.23E+00	1.74E+01	1.52E-01	9.07E-01	9.07E-01	8.34E-01	5.36E-03	4.71E-03	1.98E-02	4.77E-02	4.18E-04	2.48E-03	2.48E-03	2.28E-03
3.58E+00	8.64E+00	7.62E-02	4.42E-01	4.42E-01	4.07E-01	2.64E-03	2.32E-03	9.81E-03	2.37E-02	2.09E-04	1.21E-03	1.21E-03	1.11E-03
1.18E+00	2.18E+00	2.54E-02	9.08E-02	9.08E-02	8.35E-02	4.20E-04	3.69E-04	3.24E-03	5.96E-03	6.96E-05	2.49E-04	2.49E-04	2.29E-04
9.37E+00	1.55E+01	2.03E-01	5.61E-01	5.61E-01	5.16E-01	2.20E-03	1.93E-03	2.57E-02	4.24E-02	5.57E-04	1.54E-03	1.54E-03	1.41E-03
3.44E+00	5.37E+00	7.62E-02	1.68E-01	1.68E-01	1.54E-01	5.80E-04	5.09E-04	9.44E-03	1.47E-02	2.09E-04	4.60E-04	4.60E-04	4.23E-04
3.65E+00	8.78E+00	7.62E-02	4.64E-01	4.64E-01	4.27E-01	2.72E-03	2.39E-03	1.00E-02	2.41E-02	2.09E-04	1.27E-03	1.27E-03	1.17E-03
1.42E-02	9.01E-02	8.49E-04	2.14E-03	2.14E-03	1.97E-03	1.48E-05	1.30E-05	3.88E-05	2.47E-04	2.33E-06	5.87E-06	5.87E-06	5.40E-06
8.24E-02	1.90E-01	1.35E-03	1.40E-02	1.40E-02	1.28E-02	7.04E-05	6.19E-05	2.26E-04	5.21E-04	3.70E-06	3.82E-05	3.82E-05	3.52E-05
8.89E-02	2.45E-01	1.73E-03	1.13E-02	1.13E-02	1.04E-02	6.94E-05	6.10E-05	2.44E-04	6.72E-04	4.74E-06	3.09E-05	3.09E-05	2.85E-05
3.16E-02	7.25E-02	4.96E-04	5.66E-03	5.66E-03	5.21E-03	2.77E-05	2.43E-05	8.65E-05	1.99E-04	1.36E-06	1.55E-05	1.55E-05	1.43E-05
1.58E-01	3.64E-01	2.48E-03	2.86E-02	2.86E-02	2.63E-02	1.40E-04	1.23E-04	4.34E-04	9.97E-04	6.78E-06	7.84E-05	7.84E-05	7.21E-05

Type	Useful Life	Load Factor
Crane	18	0.43
Excavator	16	0.57
Forklift	20	0.30
Material Handling Equip	18	0.59
Other General Industrial Equip	16	0.51
Sweeper/Scrubber	16	0.68
Tractor/Loader/Backhoe	16	0.55
Yard Tractor offroad engine	8	0.65
Yard Tractor onroad engine	8	0.65

Fuel Correction Factor

t_fcf

Model Yr	Calyr 1994 -2006		
	NOX	PM	HC
1970	0.930	0.750	0.720
1971	0.930	0.750	0.720
1972	0.930	0.750	0.720
1973	0.930	0.750	0.720
1974	0.930	0.750	0.720
1975	0.930	0.750	0.720
1976	0.930	0.750	0.720
1977	0.930	0.750	0.720
1978	0.930	0.750	0.720
1979	0.930	0.750	0.720
1980	0.930	0.750	0.720
1981	0.930	0.750	0.720
1982	0.930	0.750	0.720
1983	0.930	0.750	0.720
1984	0.930	0.750	0.720
1985	0.930	0.750	0.720
1986	0.930	0.750	0.720
1987	0.930	0.750	0.720
1988	0.930	0.750	0.720
1989	0.930	0.750	0.720
1990	0.930	0.750	0.720
1991	0.930	0.750	0.720
1992	0.930	0.750	0.720
1993	0.930	0.750	0.720
1994	0.930	0.750	0.720
1995	0.930	0.750	0.720
1996	0.948	0.822	0.720
1997	0.948	0.822	0.720
1998	0.948	0.822	0.720
1999	0.948	0.822	0.720
2000	0.948	0.822	0.720
2001	0.948	0.822	0.720
2002	0.948	0.822	0.720
2003	0.948	0.822	0.720
2004	0.948	0.822	0.720
2005	0.948	0.822	0.720
2006	0.948	0.822	0.720
2007	0.948	0.822	0.720
2008	0.948	0.822	0.720
2009	0.948	0.822	0.720
2010	0.948	0.822	0.720
2011	0.948	0.822	0.720
2012	0.948	0.822	0.720
2013	0.948	0.822	0.720
2014	0.948	0.822	0.720
2015	0.948	0.822	0.720
2016	0.948	0.822	0.720
2017	0.948	0.822	0.720
2018	0.948	0.822	0.720

HP_dr

	Det. Rate			
HP	HC	CO	NOx	PM
50	51%	41%	6%	31%
120	28%	16%	14%	44%
175	28%	16%	14%	44%
250	44%	25%	21%	67%
500	44%	25%	21%	67%

***New Tier4 emfacs included with 43/57% split for 120 hp merged (diesel only)**

units = g/bhp hr

Lookup	Hp	Year	HC	CO	NOX	PM	CO2
251968	25	1968	1.84	5	6.92	0.764	10176.3
251969	25	1969	1.84	5	6.92	0.764	10176.3
251970	25	1970	1.84	5	6.92	0.764	10176.3
251971	25	1971	1.84	5	6.92	0.764	10176.3
251972	25	1972	1.84	5	6.92	0.764	10176.3
251973	25	1973	1.84	5	6.92	0.764	10176.3
251974	25	1974	1.84	5	6.92	0.764	10176.3
251975	25	1975	1.84	5	6.92	0.764	10176.3
251976	25	1976	1.84	5	6.92	0.764	10176.3
251977	25	1977	1.84	5	6.92	0.764	10176.3
251978	25	1978	1.84	5	6.92	0.764	10176.3
251979	25	1979	1.84	5	6.92	0.764	10176.3
251980	25	1980	1.84	5	6.92	0.764	10176.3
251981	25	1981	1.84	5	6.92	0.764	10176.3
251982	25	1982	1.84	5	6.92	0.764	10176.3
251983	25	1983	1.84	5	6.92	0.764	10176.3
251984	25	1984	1.84	5	6.92	0.764	10176.3
251985	25	1985	1.84	5	6.92	0.764	10176.3
251986	25	1986	1.84	5	6.92	0.764	10176.3
251987	25	1987	1.84	5	6.92	0.764	10176.3
251988	25	1988	1.84	5	6.92	0.764	10176.3
251989	25	1989	1.84	5	6.92	0.764	10176.3
251990	25	1990	1.84	5	6.92	0.764	10176.3
251991	25	1991	1.84	5	6.92	0.764	10176.3
251992	25	1992	1.84	5	6.92	0.764	10176.3
251993	25	1993	1.84	5	6.92	0.764	10176.3
251994	25	1994	1.84	5	6.92	0.764	10176.3
251995	25	1995	1.63	1.4	3.89	0.417	10176.3
251996	25	1996	1.63	1.4	3.89	0.417	10176.3
251997	25	1997	1.63	1.4	3.89	0.417	10176.3
251998	25	1998	1.63	1.4	3.89	0.417	10176.3
251999	25	1999	0.52	0.5	1.24	0.116	10176.3
252000	25	2000	0.52	0.5	1.24	0.116	10176.3
252001	25	2001	0.52	0.5	1.24	0.116	10176.3
252002	25	2002	0.52	0.5	1.24	0.116	10176.3
252003	25	2003	0.52	0.5	1.24	0.116	10176.3
252004	25	2004	0.52	0.5	1.24	0.116	10176.3
252005	25	2005	0.52	0.5	1.24	0.116	10176.3
252006	25	2006	0.52	0.5	1.24	0.116	10176.3
252007	25	2007	0.52	0.5	1.24	0.116	10176.3
252008	25	2008	0.52	0.5	1.24	0.116	10176.3
252009	25	2009	0.52	0.5	1.24	0.116	10176.3
252010	25	2010	0.52	0.5	1.24	0.116	10176.3
252011	25	2011	0.52	0.5	1.24	0.116	10176.3
252012	25	2012	0.52	0.5	1.24	0.116	10176.3
252013	25	2013	0.52	0.5	1.24	0.116	10176.3
252014	25	2014	0.52	0.5	1.24	0.116	10176.3
252015	25	2015	0.52	0.5	1.24	0.116	10176.3
252016	25	2016	0.52	0.5	1.24	0.116	10176.3
252017	25	2017	0.52	0.5	1.24	0.116	10176.3
252018	25	2018	0.52	0.5	1.24	0.116	10176.3
252019	25	2019	0.52	0.5	1.24	0.116	10176.3
252020	25	2020	0.52	0.5	1.24	0.116	10176.3
252021	25	2021	0.52	0.5	1.24	0.116	10176.3
252022	25	2022	0.52	0.5	1.24	0.116	10176.3
252023	25	2023	0.52	0.5	1.24	0.116	10176.3
252024	25	2024	0.52	0.5	1.24	0.116	10176.3
252025	25	2025	0.52	0.5	1.24	0.116	10176.3
252026	25	2026	0.52	0.5	1.24	0.116	10176.3
501969	50	1969	1.84	5	7	0.76	10176.3
501969	50	1969	1.84	5	7	0.76	10176.3
501970	50	1970	1.84	5	7	0.76	10176.3
501971	50	1971	1.84	5	7	0.76	10176.3
501972	50	1972	1.84	5	7	0.76	10176.3
501973	50	1973	1.84	5	7	0.76	10176.3
501974	50	1974	1.84	5	7	0.76	10176.3
501975	50	1975	1.84	5	7	0.76	10176.3

501976	50	1976	1.84	5	7	0.76	10176.3
501977	50	1977	1.84	5	7	0.76	10176.3
501978	50	1978	1.84	5	7	0.76	10176.3
501979	50	1979	1.84	5	7	0.76	10176.3
501980	50	1980	1.84	5	7	0.76	10176.3
501981	50	1981	1.84	5	7	0.76	10176.3
501982	50	1982	1.84	5	7	0.76	10176.3
501983	50	1983	1.84	5	7	0.76	10176.3
501984	50	1984	1.84	5	7	0.76	10176.3
501985	50	1985	1.84	5	7	0.76	10176.3
501986	50	1986	1.84	5	7	0.76	10176.3
501987	50	1987	1.84	5	7	0.76	10176.3
501988	50	1988	1.8	5	6.9	0.76	10176.3
501989	50	1989	1.8	5	6.9	0.76	10176.3
501990	50	1990	1.8	5	6.9	0.76	10176.3
501991	50	1991	1.8	5	6.9	0.76	10176.3
501992	50	1992	1.8	5	6.9	0.76	10176.3
501993	50	1993	1.8	5	6.9	0.76	10176.3
501994	50	1994	1.8	5	6.9	0.76	10176.3
501995	50	1995	1.8	5	6.9	0.76	10176.3
501996	50	1996	1.8	5	6.9	0.76	10176.3
501997	50	1997	1.8	5	6.9	0.76	10176.3
501998	50	1998	1.8	5	6.9	0.76	10176.3
501999	50	1999	1.45	4.1	5.55	0.6	10176.3
502000	50	2000	1.45	4.1	5.55	0.6	10176.3
502001	50	2001	1.45	4.1	5.55	0.6	10176.3
502002	50	2002	1.45	4.1	5.55	0.6	10176.3
502003	50	2003	1.45	4.1	5.55	0.6	10176.3
502004	50	2004	0.64	3.27	5.1	0.43	10176.3
502005	50	2005	0.37	3	4.95	0.38	10176.3
502006	50	2006	0.24	2.86	4.88	0.35	10176.3
502007	50	2007	0.24	2.86	4.88	0.35	10176.3
502008	50	2008	0.1	2.72	4.8	0.16	10176.3
502009	50	2009	0.1	2.72	4.8	0.16	10176.3
502010	50	2010	0.1	2.72	4.8	0.16	10176.3
502011	50	2011	0.1	2.72	4.8	0.16	10176.3
502012	50	2012	0.1	2.72	4.8	0.16	10176.3
502013	50	2013	0.1	2.72	2.9	0.01	10176.3
502014	50	2014	0.1	2.72	2.9	0.01	10176.3
502015	50	2015	0.1	2.72	2.9	0.01	10176.3
502016	50	2016	0.1	2.72	2.9	0.01	10176.3
502017	50	2017	0.1	2.72	2.9	0.01	10176.3
502018	50	2018	0.1	2.72	2.9	0.01	10176.3
502019	50	2019	0.1	2.72	2.9	0.01	10176.3
502020	50	2020	0.1	2.72	2.9	0.01	10176.3
502021	50	2021	0.1	2.72	2.9	0.01	10176.3
502022	50	2022	0.1	2.72	2.9	0.01	10176.3
502023	50	2023	0.1	2.72	2.9	0.01	10176.3
502024	50	2024	0.1	2.72	2.9	0.01	10176.3
502025	50	2025	0.1	2.72	2.9	0.01	10176.3
502026	50	2026	0.1	2.72	2.9	0.01	10176.3
1201968	120	1968	1.44	4.8	13	0.84	10176.3
1201969	120	1969	1.44	4.8	13	0.84	10176.3
1201970	120	1970	1.44	4.8	13	0.84	10176.3
1201971	120	1971	1.44	4.8	13	0.84	10176.3
1201972	120	1972	1.44	4.8	13	0.84	10176.3
1201973	120	1973	1.44	4.8	13	0.84	10176.3
1201974	120	1974	1.44	4.8	13	0.84	10176.3
1201975	120	1975	1.44	4.8	13	0.84	10176.3
1201976	120	1976	1.44	4.8	13	0.84	10176.3
1201977	120	1977	1.44	4.8	13	0.84	10176.3
1201978	120	1978	1.44	4.8	13	0.84	10176.3
1201979	120	1979	1.44	4.8	13	0.84	10176.3
1201980	120	1980	1.44	4.8	13	0.84	10176.3
1201981	120	1981	1.44	4.8	13	0.84	10176.3
1201982	120	1982	1.44	4.8	13	0.84	10176.3
1201983	120	1983	1.44	4.8	13	0.84	10176.3
1201984	120	1984	1.44	4.8	13	0.84	10176.3
1201985	120	1985	1.44	4.8	13	0.84	10176.3
1201986	120	1986	1.44	4.8	13	0.84	10176.3
1201987	120	1987	1.44	4.8	13	0.84	10176.3

1201988	120	1988	0.99	3.49	8.75	0.69	10176.3
1201989	120	1989	0.99	3.49	8.75	0.69	10176.3
1201990	120	1990	0.99	3.49	8.75	0.69	10176.3
1201991	120	1991	0.99	3.49	8.75	0.69	10176.3
1201992	120	1992	0.99	3.49	8.75	0.69	10176.3
1201993	120	1993	0.99	3.49	8.75	0.69	10176.3
1201994	120	1994	0.99	3.49	8.75	0.69	10176.3
1201995	120	1995	0.99	3.49	8.75	0.69	10176.3
1201996	120	1996	0.99	3.49	8.75	0.69	10176.3
1201997	120	1997	0.99	3.49	8.75	0.69	10176.3
1201998	120	1998	0.99	3.49	6.9	0.69	10176.3
1201999	120	1999	0.99	3.49	6.9	0.69	10176.3
1202000	120	2000	0.99	3.49	6.9	0.69	10176.3
1202001	120	2001	0.99	3.49	6.9	0.69	10176.3
1202002	120	2002	0.99	3.49	6.9	0.69	10176.3
1202003	120	2003	0.99	3.49	6.9	0.69	10176.3
1202004	120	2004	0.46	3.23	5.64	0.39	10176.3
1202005	120	2005	0.28	3.14	5.22	0.29	10176.3
1202006	120	2006	0.19	3.09	5.01	0.24	10176.3
1202007	120	2007	0.19	3.09	5.01	0.24	10176.3
1202008	120	2008	0.1	3.05	2.89	0.197	10176.3
1202009	120	2009	0.1	3.05	2.89	0.197	10176.3
1202010	120	2010	0.1	3.05	2.89	0.197	10176.3
1202011	120	2011	0.1	3.05	2.89	0.197	10176.3
1202012	120	2012	0.0943	3.05	2.5309	0.0659	10176.3
1202013	120	2013	0.0943	3.05	2.5309	0.01	10176.3
1202014	120	2014	0.0943	3.05	2.5309	0.01	10176.3
1202015	120	2015	0.0715	3.05	1.3966	0.01	10176.3
1202016	120	2016	0.0715	3.05	1.3966	0.01	10176.3
1202017	120	2017	0.0715	3.05	1.3966	0.01	10176.3
1202018	120	2018	0.0715	3.05	1.3966	0.01	10176.3
1202019	120	2019	0.0715	3.05	1.3966	0.01	10176.3
1202020	120	2020	0.0715	3.05	1.3966	0.01	10176.3
1202021	120	2021	0.0715	3.05	1.3966	0.01	10176.3
1202022	120	2022	0.0715	3.05	1.3966	0.01	10176.3
1202023	120	2023	0.0715	3.05	1.3966	0.01	10176.3
1202024	120	2024	0.0715	3.05	1.3966	0.01	10176.3
1202025	120	2025	0.0715	3.05	1.3966	0.01	10176.3
1202026	120	2026	0.0715	3.05	1.3966	0.01	10176.3
1751968	175	1968	1.32	4.4	14	0.77	10176.3
1751969	175	1969	1.32	4.4	14	0.77	10176.3
1751970	175	1970	1.1	4.4	13	0.66	10176.3
1751971	175	1971	1.1	4.4	13	0.66	10176.3
1751972	175	1972	1	4.4	12	0.55	10176.3
1751973	175	1973	1	4.4	12	0.55	10176.3
1751974	175	1974	1	4.4	12	0.55	10176.3
1751975	175	1975	1	4.4	12	0.55	10176.3
1751976	175	1976	1	4.4	12	0.55	10176.3
1751977	175	1977	1	4.4	12	0.55	10176.3
1751978	175	1978	1	4.4	12	0.55	10176.3
1751979	175	1979	1	4.4	12	0.55	10176.3
1751980	175	1980	0.94	4.3	11	0.55	10176.3
1751981	175	1981	0.94	4.3	11	0.55	10176.3
1751982	175	1982	0.94	4.3	11	0.55	10176.3
1751983	175	1983	0.94	4.3	11	0.55	10176.3
1751984	175	1984	0.94	4.3	11	0.55	10176.3
1751985	175	1985	0.88	4.2	11	0.55	10176.3
1751986	175	1986	0.88	4.2	11	0.55	10176.3
1751987	175	1987	0.88	4.2	11	0.55	10176.3
1751988	175	1988	0.68	2.7	8.17	0.38	10176.3
1751989	175	1989	0.68	2.7	8.17	0.38	10176.3
1751990	175	1990	0.68	2.7	8.17	0.38	10176.3
1751991	175	1991	0.68	2.7	8.17	0.38	10176.3
1751992	175	1992	0.68	2.7	8.17	0.38	10176.3
1751993	175	1993	0.68	2.7	8.17	0.38	10176.3
1751994	175	1994	0.68	2.7	8.17	0.38	10176.3
1751995	175	1995	0.68	2.7	8.17	0.38	10176.3
1751996	175	1996	0.68	2.7	8.17	0.38	10176.3
1751997	175	1997	0.68	2.7	6.9	0.38	10176.3
1751998	175	1998	0.68	2.7	6.9	0.38	10176.3
1751999	175	1999	0.68	2.7	6.9	0.38	10176.3

1752000	175	2000	0.68	2.7	6.9	0.38	10176.3
1752001	175	2001	0.68	2.7	6.9	0.38	10176.3
1752002	175	2002	0.68	2.7	6.9	0.38	10176.3
1752003	175	2003	0.33	2.7	5.26	0.24	10176.3
1752004	175	2004	0.22	2.7	4.72	0.19	10176.3
1752005	175	2005	0.16	2.7	4.44	0.16	10176.3
1752006	175	2006	0.16	2.7	4.44	0.16	10176.3
1752007	175	2007	0.1	2.7	2.45	0.14	10176.3
1752008	175	2008	0.1	2.7	2.45	0.14	10176.3
1752009	175	2009	0.1	2.7	2.45	0.14	10176.3
1752010	175	2010	0.1	2.7	2.45	0.14	10176.3
1752011	175	2011	0.1	2.7	2.45	0.14	10176.3
1752012	175	2012	0.09	2.7	2.27	0.01	10176.3
1752013	175	2013	0.09	2.7	2.27	0.01	10176.3
1752014	175	2014	0.09	2.7	2.27	0.01	10176.3
1752015	175	2015	0.05	2.7	0.27	0.01	10176.3
1752016	175	2016	0.05	2.7	0.27	0.01	10176.3
1752017	175	2017	0.05	2.7	0.27	0.01	10176.3
1752018	175	2018	0.05	2.7	0.27	0.01	10176.3
1752019	175	2019	0.05	2.7	0.27	0.01	10176.3
1752020	175	2020	0.05	2.7	0.27	0.01	10176.3
1752021	175	2021	0.05	2.7	0.27	0.01	10176.3
1752022	175	2022	0.05	2.7	0.27	0.01	10176.3
1752023	175	2023	0.05	2.7	0.27	0.01	10176.3
1752024	175	2024	0.05	2.7	0.27	0.01	10176.3
1752025	175	2025	0.05	2.7	0.27	0.01	10176.3
1752026	175	2026	0.05	2.7	0.27	0.01	10176.3
2501968	250	1968	1.32	4.4	14	0.77	10176.3
2501969	250	1969	1.32	4.4	14	0.77	10176.3
2501970	250	1970	1.1	4.4	13	0.66	10176.3
2501971	250	1971	1.1	4.4	13	0.66	10176.3
2501972	250	1972	1	4.4	12	0.55	10176.3
2501973	250	1973	1	4.4	12	0.55	10176.3
2501974	250	1974	1	4.4	12	0.55	10176.3
2501975	250	1975	1	4.4	12	0.55	10176.3
2501976	250	1976	1	4.4	12	0.55	10176.3
2501977	250	1977	1	4.4	12	0.55	10176.3
2501978	250	1978	1	4.4	12	0.55	10176.3
2501979	250	1979	1	4.4	12	0.55	10176.3
2501980	250	1980	0.94	4.3	11	0.55	10176.3
2501981	250	1981	0.94	4.3	11	0.55	10176.3
2501982	250	1982	0.94	4.3	11	0.55	10176.3
2501983	250	1983	0.94	4.3	11	0.55	10176.3
2501984	250	1984	0.94	4.3	11	0.55	10176.3
2501985	250	1985	0.88	4.2	11	0.55	10176.3
2501986	250	1986	0.88	4.2	11	0.55	10176.3
2501987	250	1987	0.88	4.2	11	0.55	10176.3
2501988	250	1988	0.68	2.7	8.17	0.38	10176.3
2501989	250	1989	0.68	2.7	8.17	0.38	10176.3
2501990	250	1990	0.68	2.7	8.17	0.38	10176.3
2501991	250	1991	0.68	2.7	8.17	0.38	10176.3
2501992	250	1992	0.68	2.7	8.17	0.38	10176.3
2501993	250	1993	0.68	2.7	8.17	0.38	10176.3
2501994	250	1994	0.68	2.7	8.17	0.38	10176.3
2501995	250	1995	0.68	2.7	8.17	0.38	10176.3
2501996	250	1996	0.32	0.92	6.25	0.15	10176.3
2501997	250	1997	0.32	0.92	6.25	0.15	10176.3
2501998	250	1998	0.32	0.92	6.25	0.15	10176.3
2501999	250	1999	0.32	0.92	6.25	0.15	10176.3
2502000	250	2000	0.32	0.92	6.25	0.15	10176.3
2502001	250	2001	0.32	0.92	6.25	0.15	10176.3
2502002	250	2002	0.32	0.92	6.25	0.15	10176.3
2502003	250	2003	0.19	0.92	5	0.12	10176.3
2502004	250	2004	0.14	0.92	4.58	0.11	10176.3
2502005	250	2005	0.12	0.92	4.38	0.11	10176.3
2502006	250	2006	0.12	0.92	4.38	0.11	10176.3
2502007	250	2007	0.1	0.92	2.45	0.11	10176.3
2502008	250	2008	0.1	0.92	2.45	0.11	10176.3
2502009	250	2009	0.1	0.92	2.45	0.11	10176.3
2502010	250	2010	0.1	0.92	2.45	0.11	10176.3
2502011	250	2011	0.07	0.92	1.36	0.01	10176.3

2502012	250	2012	0.07	0.92	1.36	0.01	10176.3
2502013	250	2013	0.07	0.92	1.36	0.01	10176.3
2502014	250	2014	0.05	0.92	0.27	0.01	10176.3
2502015	250	2015	0.05	0.92	0.27	0.01	10176.3
2502016	250	2016	0.05	0.92	0.27	0.01	10176.3
2502017	250	2017	0.05	0.92	0.27	0.01	10176.3
2502018	250	2018	0.05	0.92	0.27	0.01	10176.3
2502019	250	2019	0.05	0.92	0.27	0.01	10176.3
2502020	250	2020	0.05	0.92	0.27	0.01	10176.3
2502021	250	2021	0.05	0.92	0.27	0.01	10176.3
2502022	250	2022	0.05	0.92	0.27	0.01	10176.3
2502023	250	2023	0.05	0.92	0.27	0.01	10176.3
2502024	250	2024	0.05	0.92	0.27	0.01	10176.3
2502025	250	2025	0.05	0.92	0.27	0.01	10176.3
2502026	250	2026	0.05	0.92	0.27	0.01	10176.3
5001968	500	1968	1.26	4.2	14	0.74	10176.3
5001969	500	1969	1.26	4.2	14	0.74	10176.3
5001970	500	1970	1.05	4.2	13	0.63	10176.3
5001971	500	1971	1.05	4.2	13	0.63	10176.3
5001972	500	1972	0.95	4.2	12	0.53	10176.3
5001973	500	1973	0.95	4.2	12	0.53	10176.3
5001974	500	1974	0.95	4.2	12	0.53	10176.3
5001975	500	1975	0.95	4.2	12	0.53	10176.3
5001976	500	1976	0.95	4.2	12	0.53	10176.3
5001977	500	1977	0.95	4.2	12	0.53	10176.3
5001978	500	1978	0.95	4.2	12	0.53	10176.3
5001979	500	1979	0.95	4.2	12	0.53	10176.3
5001980	500	1980	0.9	4.2	11	0.53	10176.3
5001981	500	1981	0.9	4.2	11	0.53	10176.3
5001982	500	1982	0.9	4.2	11	0.53	10176.3
5001983	500	1983	0.9	4.2	11	0.53	10176.3
5001984	500	1984	0.9	4.2	11	0.53	10176.3
5001985	500	1985	0.84	4.1	11	0.53	10176.3
5001986	500	1986	0.84	4.1	11	0.53	10176.3
5001987	500	1987	0.84	4.1	11	0.53	10176.3
5001988	500	1988	0.68	2.7	8.17	0.38	10176.3
5001989	500	1989	0.68	2.7	8.17	0.38	10176.3
5001990	500	1990	0.68	2.7	8.17	0.38	10176.3
5001991	500	1991	0.68	2.7	8.17	0.38	10176.3
5001992	500	1992	0.68	2.7	8.17	0.38	10176.3
5001993	500	1993	0.68	2.7	8.17	0.38	10176.3
5001994	500	1994	0.68	2.7	8.17	0.38	10176.3
5001995	500	1995	0.68	2.7	8.17	0.38	10176.3
5001996	500	1996	0.32	0.92	6.25	0.15	10176.3
5001997	500	1997	0.32	0.92	6.25	0.15	10176.3
5001998	500	1998	0.32	0.92	6.25	0.15	10176.3
5001999	500	1999	0.32	0.92	6.25	0.15	10176.3
5002000	500	2000	0.32	0.92	6.25	0.15	10176.3
5002001	500	2001	0.19	0.92	4.95	0.12	10176.3
5002002	500	2002	0.14	0.92	4.51	0.11	10176.3
5002003	500	2003	0.12	0.92	4.29	0.11	10176.3
5002004	500	2004	0.12	0.92	4.29	0.11	10176.3
5002005	500	2005	0.1	0.92	4	0.11	10176.3
5002006	500	2006	0.1	0.92	2.45	0.11	10176.3
5002007	500	2007	0.1	0.92	2.45	0.11	10176.3
5002008	500	2008	0.1	0.92	2.45	0.11	10176.3
5002009	500	2009	0.1	0.92	2.45	0.11	10176.3
5002010	500	2010	0.1	0.92	2.45	0.11	10176.3
5002011	500	2011	0.07	0.92	1.36	0.01	10176.3
5002012	500	2012	0.07	0.92	1.36	0.01	10176.3
5002013	500	2013	0.07	0.92	1.36	0.01	10176.3
5002014	500	2014	0.05	0.92	0.27	0.01	10176.3
5002015	500	2015	0.05	0.92	0.27	0.01	10176.3
5002016	500	2016	0.05	0.92	0.27	0.01	10176.3
5002017	500	2017	0.05	0.92	0.27	0.01	10176.3
5002018	500	2018	0.05	0.92	0.27	0.01	10176.3
5002019	500	2019	0.05	0.92	0.27	0.01	10176.3
5002020	500	2020	0.05	0.92	0.27	0.01	10176.3
5002021	500	2021	0.05	0.92	0.27	0.01	10176.3
5002022	500	2022	0.05	0.92	0.27	0.01	10176.3
5002023	500	2023	0.05	0.92	0.27	0.01	10176.3

5002024	500	2024	0.05	0.92	0.27	0.01	10176.3
5002025	500	2025	0.05	0.92	0.27	0.01	10176.3
5002026	500	2026	0.05	0.92	0.27	0.01	10176.3
7501968	750	1968	1.26	4.2	14	0.74	10176.3
7501969	750	1969	1.26	4.2	14	0.74	10176.3
7501970	750	1970	1.05	4.2	13	0.63	10176.3
7501971	750	1971	1.05	4.2	13	0.63	10176.3
7501972	750	1972	0.95	4.2	12	0.53	10176.3
7501973	750	1973	0.95	4.2	12	0.53	10176.3
7501974	750	1974	0.95	4.2	12	0.53	10176.3
7501975	750	1975	0.95	4.2	12	0.53	10176.3
7501976	750	1976	0.95	4.2	12	0.53	10176.3
7501977	750	1977	0.95	4.2	12	0.53	10176.3
7501978	750	1978	0.95	4.2	12	0.53	10176.3
7501979	750	1979	0.95	4.2	12	0.53	10176.3
7501980	750	1980	0.9	4.2	11	0.53	10176.3
7501981	750	1981	0.9	4.2	11	0.53	10176.3
7501982	750	1982	0.9	4.2	11	0.53	10176.3
7501983	750	1983	0.9	4.2	11	0.53	10176.3
7501984	750	1984	0.9	4.2	11	0.53	10176.3
7501985	750	1985	0.84	4.1	11	0.53	10176.3
7501986	750	1986	0.84	4.1	11	0.53	10176.3
7501987	750	1987	0.84	4.1	11	0.53	10176.3
7501988	750	1988	0.68	2.7	8.17	0.38	10176.3
7501989	750	1989	0.68	2.7	8.17	0.38	10176.3
7501990	750	1990	0.68	2.7	8.17	0.38	10176.3
7501991	750	1991	0.68	2.7	8.17	0.38	10176.3
7501992	750	1992	0.68	2.7	8.17	0.38	10176.3
7501993	750	1993	0.68	2.7	8.17	0.38	10176.3
7501994	750	1994	0.68	2.7	8.17	0.38	10176.3
7501995	750	1995	0.68	2.7	8.17	0.38	10176.3
7501996	750	1996	0.32	0.92	6.25	0.15	10176.3
7501997	750	1997	0.32	0.92	6.25	0.15	10176.3
7501998	750	1998	0.32	0.92	6.25	0.15	10176.3
7501999	750	1999	0.32	0.92	6.25	0.15	10176.3
7502000	750	2000	0.32	0.92	6.25	0.15	10176.3
7502001	750	2001	0.32	0.92	6.25	0.15	10176.3
7502002	750	2002	0.19	0.92	4.95	0.12	10176.3
7502003	750	2003	0.14	0.92	4.51	0.11	10176.3
7502004	750	2004	0.12	0.92	4.29	0.11	10176.3
7502005	750	2005	0.12	0.92	4.29	0.11	10176.3
7502006	750	2006	0.1	0.92	2.45	0.11	10176.3
7502007	750	2007	0.1	0.92	2.45	0.11	10176.3
7502008	750	2008	0.1	0.92	2.45	0.11	10176.3
7502009	750	2009	0.1	0.92	2.45	0.11	10176.3
7502010	750	2010	0.1	0.92	2.45	0.11	10176.3
7502011	750	2011	0.07	0.92	1.36	0.01	10176.3
7502012	750	2012	0.07	0.92	1.36	0.01	10176.3
7502013	750	2013	0.07	0.92	1.36	0.01	10176.3
7502014	750	2014	0.05	0.92	0.27	0.01	10176.3
7502015	750	2015	0.05	0.92	0.27	0.01	10176.3
7502016	750	2016	0.05	0.92	0.27	0.01	10176.3
7502017	750	2017	0.05	0.92	0.27	0.01	10176.3
7502018	750	2018	0.05	0.92	0.27	0.01	10176.3
7502019	750	2019	0.05	0.92	0.27	0.01	10176.3
7502020	750	2020	0.05	0.92	0.27	0.01	10176.3
7502021	750	2021	0.05	0.92	0.27	0.01	10176.3
7502022	750	2022	0.05	0.92	0.27	0.01	10176.3
7502023	750	2023	0.05	0.92	0.27	0.01	10176.3
7502024	750	2024	0.05	0.92	0.27	0.01	10176.3
7502025	750	2025	0.05	0.92	0.27	0.01	10176.3
7502026	750	2026	0.05	0.92	0.27	0.01	10176.3
9991968	999	1968	1.26	4.2	14	0.74	10176.3
9991969	999	1969	1.26	4.2	14	0.74	10176.3
9991970	999	1970	1.05	4.2	13	0.63	10176.3
9991971	999	1971	1.05	4.2	13	0.63	10176.3
9991972	999	1972	0.95	4.2	12	0.53	10176.3
9991973	999	1973	0.95	4.2	12	0.53	10176.3
9991974	999	1974	0.95	4.2	12	0.53	10176.3
9991975	999	1975	0.95	4.2	12	0.53	10176.3
9991976	999	1976	0.95	4.2	12	0.53	10176.3

9991977	999	1977	0.95	4.2	12	0.53	10176.3
9991978	999	1978	0.95	4.2	12	0.53	10176.3
9991979	999	1979	0.95	4.2	12	0.53	10176.3
9991980	999	1980	0.9	4.2	11	0.53	10176.3
9991981	999	1981	0.9	4.2	11	0.53	10176.3
9991982	999	1982	0.9	4.2	11	0.53	10176.3
9991983	999	1983	0.9	4.2	11	0.53	10176.3
9991984	999	1984	0.9	4.2	11	0.53	10176.3
9991985	999	1985	0.84	4.1	11	0.53	10176.3
9991986	999	1986	0.84	4.1	11	0.53	10176.3
9991987	999	1987	0.84	4.1	11	0.53	10176.3
9991988	999	1988	0.68	2.7	8.17	0.38	10176.3
9991989	999	1989	0.68	2.7	8.17	0.38	10176.3
9991990	999	1990	0.68	2.7	8.17	0.38	10176.3
9991991	999	1991	0.68	2.7	8.17	0.38	10176.3
9991992	999	1992	0.68	2.7	8.17	0.38	10176.3
9991993	999	1993	0.68	2.7	8.17	0.38	10176.3
9991994	999	1994	0.68	2.7	8.17	0.38	10176.3
9991995	999	1995	0.68	2.7	8.17	0.38	10176.3
9991996	999	1996	0.68	2.7	8.17	0.38	10176.3
9991997	999	1997	0.68	2.7	8.17	0.38	10176.3
9991998	999	1998	0.68	2.7	8.17	0.38	10176.3
9991999	999	1999	0.68	2.7	8.17	0.38	10176.3
9992000	999	2000	0.32	0.92	6.25	0.15	10176.3
9992001	999	2001	0.32	0.92	6.25	0.15	10176.3
9992002	999	2002	0.32	0.92	6.25	0.15	10176.3
9992003	999	2003	0.32	0.92	6.25	0.15	10176.3
9992004	999	2004	0.32	0.92	6.25	0.15	10176.3
9992005	999	2005	0.32	0.92	6.25	0.15	10176.3
9992006	999	2006	0.19	0.92	4.95	0.12	10176.3
9992007	999	2007	0.14	0.92	4.51	0.11	10176.3
9992008	999	2008	0.12	0.92	4.29	0.11	10176.3
9992009	999	2009	0.12	0.92	4.29	0.11	10176.3
9992010	999	2010	0.1	0.92	4.08	0.11	10176.3
9992011	999	2011	0.1	0.92	2.36	0.06	10176.3
9992012	999	2012	0.1	0.92	2.36	0.06	10176.3
9992013	999	2013	0.1	0.92	2.36	0.06	10176.3
9992014	999	2014	0.1	0.92	2.36	0.06	10176.3
9992015	999	2015	0.05	0.92	2.36	0.02	10176.3
9992016	999	2016	0.05	0.92	2.36	0.02	10176.3
9992017	999	2017	0.05	0.92	2.36	0.02	10176.3
9992018	999	2018	0.05	0.92	2.36	0.02	10176.3
9992019	999	2019	0.05	0.92	2.36	0.02	10176.3
9992020	999	2020	0.05	0.92	2.36	0.02	10176.3
9992021	999	2021	0.05	0.92	2.36	0.02	10176.3
9992022	999	2022	0.05	0.92	2.36	0.02	10176.3
9992023	999	2023	0.05	0.92	2.36	0.02	10176.3
9992024	999	2024	0.05	0.92	2.36	0.02	10176.3
9992025	999	2025	0.05	0.92	2.36	0.02	10176.3
9992026	999	2026	0.05	0.92	2.36	0.02	10176.3

***New Tier4 emfacs included with 43/57% split for 120 hp merged (diesel only)**

units = g/bhp hr

Lookup	Hp	Year	HC	CO	NOX	PM	CO2
251968	25	1968	1.3	15.5	6	0.6	10176.3
251969	25	1969	1.3	15.5	6	0.6	10176.3
251970	25	1970	1.3	15.5	6	0.6	10176.3
251971	25	1971	1.3	15.5	6	0.6	10176.3
251972	25	1972	1.3	15.5	6	0.6	10176.3
251973	25	1973	1.3	15.5	6	0.6	10176.3
251974	25	1974	1.3	15.5	6	0.6	10176.3
251975	25	1975	1.3	15.5	6	0.6	10176.3
251976	25	1976	1.3	15.5	6	0.6	10176.3
251977	25	1977	1.3	15.5	6	0.6	10176.3
251978	25	1978	1.3	15.5	6	0.6	10176.3
251979	25	1979	1.3	15.5	6	0.6	10176.3
251980	25	1980	1.3	15.5	6	0.6	10176.3
251981	25	1981	1.3	15.5	6	0.6	10176.3
251982	25	1982	1.3	15.5	6	0.6	10176.3
251983	25	1983	1.3	15.5	6	0.6	10176.3
251984	25	1984	1.3	15.5	6	0.6	10176.3
251985	25	1985	1.3	15.5	6	0.6	10176.3
251986	25	1986	1.3	15.5	6	0.6	10176.3
251987	25	1987	1.3	15.5	6	0.6	10176.3
251988	25	1988	1.3	15.5	6	0.6	10176.3
251989	25	1989	1.3	15.5	6	0.6	10176.3
251990	25	1990	1.3	15.5	6	0.6	10176.3
251991	25	1991	1.3	15.5	5	0.25	10176.3
251992	25	1992	1.3	15.5	5	0.25	10176.3
251993	25	1993	1.3	15.5	5	0.25	10176.3
251994	25	1994	1.3	15.5	5	0.1	10176.3
251995	25	1995	1.3	15.5	5	0.1	10176.3
251996	25	1996	1.3	15.5	5	0.1	10176.3
251997	25	1997	1.3	15.5	5	0.1	10176.3
251998	25	1998	1.3	15.5	5	0.1	10176.3
251999	25	1999	1.3	15.5	5	0.1	10176.3
252000	25	2000	1.3	15.5	5	0.1	10176.3
252001	25	2001	1.3	15.5	5	0.1	10176.3
252002	25	2002	1.3	15.5	5	0.1	10176.3
252003	25	2003	1.3	15.5	5	0.1	10176.3
252004	25	2004	0.5	15.5	2	0.1	10176.3
252005	25	2005	0.5	15.5	2	0.1	10176.3
252006	25	2006	0.5	15.5	2	0.1	10176.3
252007	25	2007	0.14	15.5	2	0.01	10176.3
252008	25	2008	0.14	15.5	2	0.01	10176.3
252009	25	2009	0.14	15.5	2	0.01	10176.3
252010	25	2010	0.14	15.5	2	0.01	10176.3
252011	25	2011	0.14	15.5	2	0.01	10176.3
252012	25	2012	0.14	15.5	2	0.01	10176.3
252013	25	2013	0.14	15.5	2	0.01	10176.3
252014	25	2014	0.14	15.5	2	0.01	10176.3
252015	25	2015	0.14	15.5	2	0.01	10176.3
252016	25	2016	0.14	15.5	2	0.01	10176.3
252017	25	2017	0.14	15.5	2	0.01	10176.3
252018	25	2018	0.14	15.5	2	0.01	10176.3
252019	25	2019	0.14	15.5	2	0.01	10176.3
252020	25	2020	0.14	15.5	2	0.01	10176.3
252021	25	2021	0.14	15.5	2	0.01	10176.3
252022	25	2022	0.14	15.5	2	0.01	10176.3
252023	25	2023	0.14	15.5	2	0.01	10176.3
252024	25	2024	0.14	15.5	2	0.01	10176.3
252025	25	2025	0.14	15.5	2	0.01	10176.3
252026	25	2026	0.14	15.5	2	0.01	10176.3
501969	50	1969	1.3	15.5	6	0.6	10176.3
501969	50	1969	1.3	15.5	6	0.6	10176.3
501970	50	1970	1.3	15.5	6	0.6	10176.3
501971	50	1971	1.3	15.5	6	0.6	10176.3
501972	50	1972	1.3	15.5	6	0.6	10176.3
501973	50	1973	1.3	15.5	6	0.6	10176.3
501974	50	1974	1.3	15.5	6	0.6	10176.3
501975	50	1975	1.3	15.5	6	0.6	10176.3
501976	50	1976	1.3	15.5	6	0.6	10176.3
501977	50	1977	1.3	15.5	6	0.6	10176.3
501978	50	1978	1.3	15.5	6	0.6	10176.3
501979	50	1979	1.3	15.5	6	0.6	10176.3
501980	50	1980	1.3	15.5	6	0.6	10176.3
501981	50	1981	1.3	15.5	6	0.6	10176.3
501982	50	1982	1.3	15.5	6	0.6	10176.3
501983	50	1983	1.3	15.5	6	0.6	10176.3
501984	50	1984	1.3	15.5	6	0.6	10176.3
501985	50	1985	1.3	15.5	6	0.6	10176.3

501986	50	1986	1.3	15.5	6	0.6	10176.3
501987	50	1987	1.3	15.5	6	0.6	10176.3
501988	50	1988	1.3	15.5	6	0.6	10176.3
501989	50	1989	1.3	15.5	6	0.6	10176.3
501990	50	1990	1.3	15.5	6	0.6	10176.3
501991	50	1991	1.3	15.5	5	0.25	10176.3
501992	50	1992	1.3	15.5	5	0.25	10176.3
501993	50	1993	1.3	15.5	5	0.25	10176.3
501994	50	1994	1.3	15.5	5	0.1	10176.3
501995	50	1995	1.3	15.5	5	0.1	10176.3
501996	50	1996	1.3	15.5	5	0.1	10176.3
501997	50	1997	1.3	15.5	5	0.1	10176.3
501998	50	1998	1.3	15.5	5	0.1	10176.3
501999	50	1999	1.3	15.5	5	0.1	10176.3
502000	50	2000	1.3	15.5	5	0.1	10176.3
502001	50	2001	1.3	15.5	5	0.1	10176.3
502002	50	2002	1.3	15.5	5	0.1	10176.3
502003	50	2003	1.3	15.5	5	0.1	10176.3
502004	50	2004	0.5	15.5	2	0.1	10176.3
502005	50	2005	0.5	15.5	2	0.1	10176.3
502006	50	2006	0.5	15.5	2	0.1	10176.3
502007	50	2007	0.14	15.5	1.1	0.01	10176.3
502008	50	2008	0.14	15.5	1.1	0.01	10176.3
502009	50	2009	0.14	15.5	1.1	0.01	10176.3
502010	50	2010	0.14	15.5	0.2	0.01	10176.3
502011	50	2011	0.14	15.5	0.2	0.01	10176.3
502012	50	2012	0.14	15.5	0.2	0.01	10176.3
502013	50	2013	0.14	15.5	0.2	0.01	10176.3
502014	50	2014	0.14	15.5	0.2	0.01	10176.3
502015	50	2015	0.14	15.5	0.2	0.01	10176.3
502016	50	2016	0.14	15.5	0.2	0.01	10176.3
502017	50	2017	0.14	15.5	0.2	0.01	10176.3
502018	50	2018	0.14	15.5	0.2	0.01	10176.3
502019	50	2019	0.14	15.5	0.2	0.01	10176.3
502020	50	2020	0.14	15.5	0.2	0.01	10176.3
502021	50	2021	0.14	15.5	0.2	0.01	10176.3
502022	50	2022	0.14	15.5	0.2	0.01	10176.3
502023	50	2023	0.14	15.5	0.2	0.01	10176.3
502024	50	2024	0.14	15.5	0.2	0.01	10176.3
502025	50	2025	0.14	15.5	0.2	0.01	10176.3
502026	50	2026	0.14	15.5	0.2	0.01	10176.3
1201968	120	1968	1.3	15.5	6	0.6	10176.3
1201969	120	1969	1.3	15.5	6	0.6	10176.3
1201970	120	1970	1.3	15.5	6	0.6	10176.3
1201971	120	1971	1.3	15.5	6	0.6	10176.3
1201972	120	1972	1.3	15.5	6	0.6	10176.3
1201973	120	1973	1.3	15.5	6	0.6	10176.3
1201974	120	1974	1.3	15.5	6	0.6	10176.3
1201975	120	1975	1.3	15.5	6	0.6	10176.3
1201976	120	1976	1.3	15.5	6	0.6	10176.3
1201977	120	1977	1.3	15.5	6	0.6	10176.3
1201978	120	1978	1.3	15.5	6	0.6	10176.3
1201979	120	1979	1.3	15.5	6	0.6	10176.3
1201980	120	1980	1.3	15.5	6	0.6	10176.3
1201981	120	1981	1.3	15.5	6	0.6	10176.3
1201982	120	1982	1.3	15.5	6	0.6	10176.3
1201983	120	1983	1.3	15.5	6	0.6	10176.3
1201984	120	1984	1.3	15.5	6	0.6	10176.3
1201985	120	1985	1.3	15.5	6	0.6	10176.3
1201986	120	1986	1.3	15.5	6	0.6	10176.3
1201987	120	1987	1.3	15.5	6	0.6	10176.3
1201988	120	1988	1.3	15.5	6	0.6	10176.3
1201989	120	1989	1.3	15.5	6	0.6	10176.3
1201990	120	1990	1.3	15.5	6	0.6	10176.3
1201991	120	1991	1.3	15.5	5	0.25	10176.3
1201992	120	1992	1.3	15.5	5	0.25	10176.3
1201993	120	1993	1.3	15.5	5	0.25	10176.3
1201994	120	1994	1.3	15.5	5	0.1	10176.3
1201995	120	1995	1.3	15.5	5	0.1	10176.3
1201996	120	1996	1.3	15.5	5	0.1	10176.3
1201997	120	1997	1.3	15.5	5	0.1	10176.3
1201998	120	1998	1.3	15.5	5	0.1	10176.3
1201999	120	1999	1.3	15.5	5	0.1	10176.3
1202000	120	2000	1.3	15.5	5	0.1	10176.3
1202001	120	2001	1.3	15.5	5	0.1	10176.3
1202002	120	2002	1.3	15.5	5	0.1	10176.3
1202003	120	2003	1.3	15.5	5	0.1	10176.3
1202004	120	2004	0.5	15.5	2	0.1	10176.3
1202005	120	2005	0.5	15.5	2	0.1	10176.3
1202006	120	2006	0.5	15.5	2	0.1	10176.3
1202007	120	2007	0.14	15.5	1.1	0.01	10176.3

1202008	120	2008	0.14	15.5	1.1	0.01	10176.3
1202009	120	2009	0.14	15.5	1.1	0.01	10176.3
1202010	120	2010	0.14	15.5	0.2	0.01	10176.3
1202011	120	2011	0.14	15.5	0.2	0.01	10176.3
1202012	120	2012	0.14	15.5	0.2	0.01	10176.3
1202013	120	2013	0.14	15.5	0.2	0.01	10176.3
1202014	120	2014	0.14	15.5	0.2	0.01	10176.3
1202015	120	2015	0.14	15.5	0.2	0.01	10176.3
1202016	120	2016	0.14	15.5	0.2	0.01	10176.3
1202017	120	2017	0.14	15.5	0.2	0.01	10176.3
1202018	120	2018	0.14	15.5	0.2	0.01	10176.3
1202019	120	2019	0.14	15.5	0.2	0.01	10176.3
1202020	120	2020	0.14	15.5	0.2	0.01	10176.3
1202021	120	2021	0.14	15.5	0.2	0.01	10176.3
1202022	120	2022	0.14	15.5	0.2	0.01	10176.3
1202023	120	2023	0.14	15.5	0.2	0.01	10176.3
1202024	120	2024	0.14	15.5	0.2	0.01	10176.3
1202025	120	2025	0.14	15.5	0.2	0.01	10176.3
1202026	120	2026	0.14	15.5	0.2	0.01	10176.3
1751968	175	1968	1.3	15.5	6	0.6	10176.3
1751969	175	1969	1.3	15.5	6	0.6	10176.3
1751970	175	1970	1.3	15.5	6	0.6	10176.3
1751971	175	1971	1.3	15.5	6	0.6	10176.3
1751972	175	1972	1.3	15.5	6	0.6	10176.3
1751973	175	1973	1.3	15.5	6	0.6	10176.3
1751974	175	1974	1.3	15.5	6	0.6	10176.3
1751975	175	1975	1.3	15.5	6	0.6	10176.3
1751976	175	1976	1.3	15.5	6	0.6	10176.3
1751977	175	1977	1.3	15.5	6	0.6	10176.3
1751978	175	1978	1.3	15.5	6	0.6	10176.3
1751979	175	1979	1.3	15.5	6	0.6	10176.3
1751980	175	1980	1.3	15.5	6	0.6	10176.3
1751981	175	1981	1.3	15.5	6	0.6	10176.3
1751982	175	1982	1.3	15.5	6	0.6	10176.3
1751983	175	1983	1.3	15.5	6	0.6	10176.3
1751984	175	1984	1.3	15.5	6	0.6	10176.3
1751985	175	1985	1.3	15.5	6	0.6	10176.3
1751986	175	1986	1.3	15.5	6	0.6	10176.3
1751987	175	1987	1.3	15.5	6	0.6	10176.3
1751988	175	1988	1.3	15.5	6	0.6	10176.3
1751989	175	1989	1.3	15.5	6	0.6	10176.3
1751990	175	1990	1.3	15.5	6	0.6	10176.3
1751991	175	1991	1.3	15.5	5	0.25	10176.3
1751992	175	1992	1.3	15.5	5	0.25	10176.3
1751993	175	1993	1.3	15.5	5	0.25	10176.3
1751994	175	1994	1.3	15.5	5	0.1	10176.3
1751995	175	1995	1.3	15.5	5	0.1	10176.3
1751996	175	1996	1.3	15.5	5	0.1	10176.3
1751997	175	1997	1.3	15.5	5	0.1	10176.3
1751998	175	1998	1.3	15.5	5	0.1	10176.3
1751999	175	1999	1.3	15.5	5	0.1	10176.3
1752000	175	2000	1.3	15.5	5	0.1	10176.3
1752001	175	2001	1.3	15.5	5	0.1	10176.3
1752002	175	2002	1.3	15.5	5	0.1	10176.3
1752003	175	2003	1.3	15.5	5	0.1	10176.3
1752004	175	2004	0.5	15.5	2	0.1	10176.3
1752005	175	2005	0.5	15.5	2	0.1	10176.3
1752006	175	2006	0.5	15.5	2	0.1	10176.3
1752007	175	2007	0.14	15.5	1.1	0.01	10176.3
1752008	175	2008	0.14	15.5	1.1	0.01	10176.3
1752009	175	2009	0.14	15.5	1.1	0.01	10176.3
1752010	175	2010	0.14	15.5	0.2	0.01	10176.3
1752011	175	2011	0.14	15.5	0.2	0.01	10176.3
1752012	175	2012	0.14	15.5	0.2	0.01	10176.3
1752013	175	2013	0.14	15.5	0.2	0.01	10176.3
1752014	175	2014	0.14	15.5	0.2	0.01	10176.3
1752015	175	2015	0.14	15.5	0.2	0.01	10176.3
1752016	175	2016	0.14	15.5	0.2	0.01	10176.3
1752017	175	2017	0.14	15.5	0.2	0.01	10176.3
1752018	175	2018	0.14	15.5	0.2	0.01	10176.3
1752019	175	2019	0.14	15.5	0.2	0.01	10176.3
1752020	175	2020	0.14	15.5	0.2	0.01	10176.3
1752021	175	2021	0.14	15.5	0.2	0.01	10176.3
1752022	175	2022	0.14	15.5	0.2	0.01	10176.3
1752023	175	2023	0.14	15.5	0.2	0.01	10176.3
1752024	175	2024	0.14	15.5	0.2	0.01	10176.3
1752025	175	2025	0.14	15.5	0.2	0.01	10176.3
1752026	175	2026	0.14	15.5	0.2	0.01	10176.3
2501968	250	1968	1.3	15.5	6	0.6	10176.3
2501969	250	1969	1.3	15.5	6	0.6	10176.3
2501970	250	1970	1.3	15.5	6	0.6	10176.3

2501971	250	1971	1.3	15.5	6	0.6	10176.3
2501972	250	1972	1.3	15.5	6	0.6	10176.3
2501973	250	1973	1.3	15.5	6	0.6	10176.3
2501974	250	1974	1.3	15.5	6	0.6	10176.3
2501975	250	1975	1.3	15.5	6	0.6	10176.3
2501976	250	1976	1.3	15.5	6	0.6	10176.3
2501977	250	1977	1.3	15.5	6	0.6	10176.3
2501978	250	1978	1.3	15.5	6	0.6	10176.3
2501979	250	1979	1.3	15.5	6	0.6	10176.3
2501980	250	1980	1.3	15.5	6	0.6	10176.3
2501981	250	1981	1.3	15.5	6	0.6	10176.3
2501982	250	1982	1.3	15.5	6	0.6	10176.3
2501983	250	1983	1.3	15.5	6	0.6	10176.3
2501984	250	1984	1.3	15.5	6	0.6	10176.3
2501985	250	1985	1.3	15.5	6	0.6	10176.3
2501986	250	1986	1.3	15.5	6	0.6	10176.3
2501987	250	1987	1.3	15.5	6	0.6	10176.3
2501988	250	1988	1.3	15.5	6	0.6	10176.3
2501989	250	1989	1.3	15.5	6	0.6	10176.3
2501990	250	1990	1.3	15.5	6	0.6	10176.3
2501991	250	1991	1.3	15.5	5	0.25	10176.3
2501992	250	1992	1.3	15.5	5	0.25	10176.3
2501993	250	1993	1.3	15.5	5	0.25	10176.3
2501994	250	1994	1.3	15.5	5	0.1	10176.3
2501995	250	1995	1.3	15.5	5	0.1	10176.3
2501996	250	1996	1.3	15.5	5	0.1	10176.3
2501997	250	1997	1.3	15.5	5	0.1	10176.3
2501998	250	1998	1.3	15.5	5	0.1	10176.3
2501999	250	1999	1.3	15.5	5	0.1	10176.3
2502000	250	2000	1.3	15.5	5	0.1	10176.3
2502001	250	2001	1.3	15.5	5	0.1	10176.3
2502002	250	2002	1.3	15.5	5	0.1	10176.3
2502003	250	2003	1.3	15.5	5	0.1	10176.3
2502004	250	2004	0.5	15.5	2	0.1	10176.3
2502005	250	2005	0.5	15.5	2	0.1	10176.3
2502006	250	2006	0.5	15.5	2	0.1	10176.3
2502007	250	2007	0.14	15.5	1.1	0.01	10176.3
2502008	250	2008	0.14	15.5	1.1	0.01	10176.3
2502009	250	2009	0.14	15.5	1.1	0.01	10176.3
2502010	250	2010	0.14	15.5	0.2	0.01	10176.3
2502011	250	2011	0.14	15.5	0.2	0.01	10176.3
2502012	250	2012	0.14	15.5	0.2	0.01	10176.3
2502013	250	2013	0.14	15.5	0.2	0.01	10176.3
2502014	250	2014	0.14	15.5	0.2	0.01	10176.3
2502015	250	2015	0.14	15.5	0.2	0.01	10176.3
2502016	250	2016	0.14	15.5	0.2	0.01	10176.3
2502017	250	2017	0.14	15.5	0.2	0.01	10176.3
2502018	250	2018	0.14	15.5	0.2	0.01	10176.3
2502019	250	2019	0.14	15.5	0.2	0.01	10176.3
2502020	250	2020	0.14	15.5	0.2	0.01	10176.3
2502021	250	2021	0.14	15.5	0.2	0.01	10176.3
2502022	250	2022	0.14	15.5	0.2	0.01	10176.3
2502023	250	2023	0.14	15.5	0.2	0.01	10176.3
2502024	250	2024	0.14	15.5	0.2	0.01	10176.3
2502025	250	2025	0.14	15.5	0.2	0.01	10176.3
2502026	250	2026	0.14	15.5	0.2	0.01	10176.3
5001968	500	1968	1.3	15.5	6	0.6	10176.3
5001969	500	1969	1.3	15.5	6	0.6	10176.3
5001970	500	1970	1.3	15.5	6	0.6	10176.3
5001971	500	1971	1.3	15.5	6	0.6	10176.3
5001972	500	1972	1.3	15.5	6	0.6	10176.3
5001973	500	1973	1.3	15.5	6	0.6	10176.3
5001974	500	1974	1.3	15.5	6	0.6	10176.3
5001975	500	1975	1.3	15.5	6	0.6	10176.3
5001976	500	1976	1.3	15.5	6	0.6	10176.3
5001977	500	1977	1.3	15.5	6	0.6	10176.3
5001978	500	1978	1.3	15.5	6	0.6	10176.3
5001979	500	1979	1.3	15.5	6	0.6	10176.3
5001980	500	1980	1.3	15.5	6	0.6	10176.3
5001981	500	1981	1.3	15.5	6	0.6	10176.3
5001982	500	1982	1.3	15.5	6	0.6	10176.3
5001983	500	1983	1.3	15.5	6	0.6	10176.3
5001984	500	1984	1.3	15.5	6	0.6	10176.3
5001985	500	1985	1.3	15.5	6	0.6	10176.3
5001986	500	1986	1.3	15.5	6	0.6	10176.3
5001987	500	1987	1.3	15.5	6	0.6	10176.3
5001988	500	1988	1.3	15.5	6	0.6	10176.3
5001989	500	1989	1.3	15.5	6	0.6	10176.3
5001990	500	1990	1.3	15.5	6	0.6	10176.3
5001991	500	1991	1.3	15.5	5	0.25	10176.3
5001992	500	1992	1.3	15.5	5	0.25	10176.3

5001993	500	1993	1.3	15.5	5	0.25	10176.3
5001994	500	1994	1.3	15.5	5	0.1	10176.3
5001995	500	1995	1.3	15.5	5	0.1	10176.3
5001996	500	1996	1.3	15.5	5	0.1	10176.3
5001997	500	1997	1.3	15.5	5	0.1	10176.3
5001998	500	1998	1.3	15.5	5	0.1	10176.3
5001999	500	1999	1.3	15.5	5	0.1	10176.3
5002000	500	2000	1.3	15.5	5	0.1	10176.3
5002001	500	2001	1.3	15.5	5	0.1	10176.3
5002002	500	2002	1.3	15.5	5	0.1	10176.3
5002003	500	2003	1.3	15.5	5	0.1	10176.3
5002004	500	2004	0.5	15.5	2	0.1	10176.3
5002005	500	2005	0.5	15.5	2	0.1	10176.3
5002006	500	2006	0.5	15.5	2	0.1	10176.3
5002007	500	2007	0.14	15.5	1.1	0.01	10176.3
5002008	500	2008	0.14	15.5	1.1	0.01	10176.3
5002009	500	2009	0.14	15.5	1.1	0.01	10176.3
5002010	500	2010	0.14	15.5	0.2	0.01	10176.3
5002011	500	2011	0.14	15.5	0.2	0.01	10176.3
5002012	500	2012	0.14	15.5	0.2	0.01	10176.3
5002013	500	2013	0.14	15.5	0.2	0.01	10176.3
5002014	500	2014	0.14	15.5	0.2	0.01	10176.3
5002015	500	2015	0.14	15.5	0.2	0.01	10176.3
5002016	500	2016	0.14	15.5	0.2	0.01	10176.3
5002017	500	2017	0.14	15.5	0.2	0.01	10176.3
5002018	500	2018	0.14	15.5	0.2	0.01	10176.3
5002019	500	2019	0.14	15.5	0.2	0.01	10176.3
5002020	500	2020	0.14	15.5	0.2	0.01	10176.3
5002021	500	2021	0.14	15.5	0.2	0.01	10176.3
5002022	500	2022	0.14	15.5	0.2	0.01	10176.3
5002023	500	2023	0.14	15.5	0.2	0.01	10176.3
5002024	500	2024	0.14	15.5	0.2	0.01	10176.3
5002025	500	2025	0.14	15.5	0.2	0.01	10176.3
5002026	500	2026	0.14	15.5	0.2	0.01	10176.3
7501968	750	1968	1.3	15.5	6	0.6	10176.3
7501969	750	1969	1.3	15.5	6	0.6	10176.3
7501970	750	1970	1.3	15.5	6	0.6	10176.3
7501971	750	1971	1.3	15.5	6	0.6	10176.3
7501972	750	1972	1.3	15.5	6	0.6	10176.3
7501973	750	1973	1.3	15.5	6	0.6	10176.3
7501974	750	1974	1.3	15.5	6	0.6	10176.3
7501975	750	1975	1.3	15.5	6	0.6	10176.3
7501976	750	1976	1.3	15.5	6	0.6	10176.3
7501977	750	1977	1.3	15.5	6	0.6	10176.3
7501978	750	1978	1.3	15.5	6	0.6	10176.3
7501979	750	1979	1.3	15.5	6	0.6	10176.3
7501980	750	1980	1.3	15.5	6	0.6	10176.3
7501981	750	1981	1.3	15.5	6	0.6	10176.3
7501982	750	1982	1.3	15.5	6	0.6	10176.3
7501983	750	1983	1.3	15.5	6	0.6	10176.3
7501984	750	1984	1.3	15.5	6	0.6	10176.3
7501985	750	1985	1.3	15.5	6	0.6	10176.3
7501986	750	1986	1.3	15.5	6	0.6	10176.3
7501987	750	1987	1.3	15.5	6	0.6	10176.3
7501988	750	1988	1.3	15.5	6	0.6	10176.3
7501989	750	1989	1.3	15.5	6	0.6	10176.3
7501990	750	1990	1.3	15.5	6	0.6	10176.3
7501991	750	1991	1.3	15.5	5	0.25	10176.3
7501992	750	1992	1.3	15.5	5	0.25	10176.3
7501993	750	1993	1.3	15.5	5	0.25	10176.3
7501994	750	1994	1.3	15.5	5	0.1	10176.3
7501995	750	1995	1.3	15.5	5	0.1	10176.3
7501996	750	1996	1.3	15.5	5	0.1	10176.3
7501997	750	1997	1.3	15.5	5	0.1	10176.3
7501998	750	1998	1.3	15.5	5	0.1	10176.3
7501999	750	1999	1.3	15.5	5	0.1	10176.3
7502000	750	2000	1.3	15.5	5	0.1	10176.3
7502001	750	2001	1.3	15.5	5	0.1	10176.3
7502002	750	2002	1.3	15.5	5	0.1	10176.3
7502003	750	2003	1.3	15.5	5	0.1	10176.3
7502004	750	2004	0.5	15.5	2	0.1	10176.3
7502005	750	2005	0.5	15.5	2	0.1	10176.3
7502006	750	2006	0.5	15.5	2	0.1	10176.3
7502007	750	2007	0.14	15.5	1.1	0.01	10176.3
7502008	750	2008	0.14	15.5	1.1	0.01	10176.3
7502009	750	2009	0.14	15.5	1.1	0.01	10176.3
7502010	750	2010	0.14	15.5	0.2	0.01	10176.3
7502011	750	2011	0.14	15.5	0.2	0.01	10176.3
7502012	750	2012	0.14	15.5	0.2	0.01	10176.3
7502013	750	2013	0.14	15.5	0.2	0.01	10176.3
7502014	750	2014	0.14	15.5	0.2	0.01	10176.3

7502015	750	2015	0.14	15.5	0.2	0.01	10176.3
7502016	750	2016	0.14	15.5	0.2	0.01	10176.3
7502017	750	2017	0.14	15.5	0.2	0.01	10176.3
7502018	750	2018	0.14	15.5	0.2	0.01	10176.3
7502019	750	2019	0.14	15.5	0.2	0.01	10176.3
7502020	750	2020	0.14	15.5	0.2	0.01	10176.3
7502021	750	2021	0.14	15.5	0.2	0.01	10176.3
7502022	750	2022	0.14	15.5	0.2	0.01	10176.3
7502023	750	2023	0.14	15.5	0.2	0.01	10176.3
7502024	750	2024	0.14	15.5	0.2	0.01	10176.3
7502025	750	2025	0.14	15.5	0.2	0.01	10176.3
7502026	750	2026	0.14	15.5	0.2	0.01	10176.3
9991968	999	1968	1.3	15.5	6	0.6	10176.3
9991969	999	1969	1.3	15.5	6	0.6	10176.3
9991970	999	1970	1.3	15.5	6	0.6	10176.3
9991971	999	1971	1.3	15.5	6	0.6	10176.3
9991972	999	1972	1.3	15.5	6	0.6	10176.3
9991973	999	1973	1.3	15.5	6	0.6	10176.3
9991974	999	1974	1.3	15.5	6	0.6	10176.3
9991975	999	1975	1.3	15.5	6	0.6	10176.3
9991976	999	1976	1.3	15.5	6	0.6	10176.3
9991977	999	1977	1.3	15.5	6	0.6	10176.3
9991978	999	1978	1.3	15.5	6	0.6	10176.3
9991979	999	1979	1.3	15.5	6	0.6	10176.3
9991980	999	1980	1.3	15.5	6	0.6	10176.3
9991981	999	1981	1.3	15.5	6	0.6	10176.3
9991982	999	1982	1.3	15.5	6	0.6	10176.3
9991983	999	1983	1.3	15.5	6	0.6	10176.3
9991984	999	1984	1.3	15.5	6	0.6	10176.3
9991985	999	1985	1.3	15.5	6	0.6	10176.3
9991986	999	1986	1.3	15.5	6	0.6	10176.3
9991987	999	1987	1.3	15.5	6	0.6	10176.3
9991988	999	1988	1.3	15.5	6	0.6	10176.3
9991989	999	1989	1.3	15.5	6	0.6	10176.3
9991990	999	1990	1.3	15.5	6	0.6	10176.3
9991991	999	1991	1.3	15.5	5	0.25	10176.3
9991992	999	1992	1.3	15.5	5	0.25	10176.3
9991993	999	1993	1.3	15.5	5	0.25	10176.3
9991994	999	1994	1.3	15.5	5	0.1	10176.3
9991995	999	1995	1.3	15.5	5	0.1	10176.3
9991996	999	1996	1.3	15.5	5	0.1	10176.3
9991997	999	1997	1.3	15.5	5	0.1	10176.3
9991998	999	1998	1.3	15.5	5	0.1	10176.3
9991999	999	1999	1.3	15.5	5	0.1	10176.3
9992000	999	2000	1.3	15.5	5	0.1	10176.3
9992001	999	2001	1.3	15.5	5	0.1	10176.3
9992002	999	2002	1.3	15.5	5	0.1	10176.3
9992003	999	2003	1.3	15.5	5	0.1	10176.3
9992004	999	2004	0.5	15.5	2	0.1	10176.3
9992005	999	2005	0.5	15.5	2	0.1	10176.3
9992006	999	2006	0.5	15.5	2	0.1	10176.3
9992007	999	2007	0.14	15.5	1.1	0.01	10176.3
9992008	999	2008	0.14	15.5	1.1	0.01	10176.3
9992009	999	2009	0.14	15.5	1.1	0.01	10176.3
9992010	999	2010	0.14	15.5	0.2	0.01	10176.3
9992011	999	2011	0.14	15.5	0.2	0.01	10176.3
9992012	999	2012	0.14	15.5	0.2	0.01	10176.3
9992013	999	2013	0.14	15.5	0.2	0.01	10176.3
9992014	999	2014	0.14	15.5	0.2	0.01	10176.3
9992015	999	2015	0.14	15.5	0.2	0.01	10176.3
9992016	999	2016	0.14	15.5	0.2	0.01	10176.3
9992017	999	2017	0.14	15.5	0.2	0.01	10176.3
9992018	999	2018	0.14	15.5	0.2	0.01	10176.3
9992019	999	2019	0.14	15.5	0.2	0.01	10176.3
9992020	999	2020	0.14	15.5	0.2	0.01	10176.3
9992021	999	2021	0.14	15.5	0.2	0.01	10176.3
9992022	999	2022	0.14	15.5	0.2	0.01	10176.3
9992023	999	2023	0.14	15.5	0.2	0.01	10176.3
9992024	999	2024	0.14	15.5	0.2	0.01	10176.3
9992025	999	2025	0.14	15.5	0.2	0.01	10176.3
9992026	999	2026	0.14	15.5	0.2	0.01	10176.3

ARB Equipment	HP Bin	SOX (g SOX/hp-hr)
Excavator	50	0.0686448
Excavator	120	0.0622888
Excavator	175	0.0597464
Excavator	250	0.0597464
Excavator	500	0.0521192
Excavator	750	0.0533904
Crane	50	0.0686448
Crane	120	0.0622888
Crane	175	0.0597464
Crane	250	0.0597464
Crane	500	0.0521192
Crane	750	0.0533904
Crane	999	0.0533904
Forklift	50	0.0686448
Forklift	120	0.0622888
Forklift	175	0.0597464
Forklift	250	0.0597464
Forklift	500	0.0521192
Material Handling Equip	120	0.0597464
Other General Industrial Equip	50	0.0686448
Other General Industrial Equip	120	0.0622888
Other General Industrial Equip	175	0.0597464
Other General Industrial Equip	250	0.0597464
Other General Industrial Equip	500	0.0521192
Other General Industrial Equip	750	0.0533904
Other General Industrial Equip	999	0.0533904
Sweeper/Scrubber	50	0.0686448
Sweeper/Scrubber	120	0.0622888
Sweeper/Scrubber	175	0.0597464
Sweeper/Scrubber	250	0.0597464
Tractor/Loader/Backhoe	50	0.0686448
Tractor/Loader/Backhoe	120	0.0622888
Tractor/Loader/Backhoe	175	0.0597464
Tractor/Loader/Backhoe	250	0.0597464
Tractor/Loader/Backhoe	500	0.0597464
Tractor/Loader/Backhoe	750	0.0597464
Yard Tractor offroad engine	120	0.0622888
Yard Tractor offroad engine	175	0.0597464
Yard Tractor offroad engine	250	0.0597464
Yard Tractor offroad engine	750	0.0533904
Yard Tractor offroad engine	999	0.0533904
Yard Tractor onroad engine	120	0.0622888
Yard Tractor onroad engine	175	0.0597464
Yard Tractor onroad engine	250	0.0597464
Yard Tractor onroad engine	750	0.0533904
Yard Tractor onroad engine	999	0.0533904

Engine changes	Emission Changes %			
	HC	CO	NOx	PM
DOC	0.7	0.7	0	0.3
DPF (P)	0.9	0.9	0	0.85
DPF (A)	0	0	0	0.85
Emulsified Fuel	0	0	0.15	0.3
Emulsified Fuel+ DOC	0	0	0.2	0.5

Equipment Types	Code
Crane	1
Excavator	2
Forklift	3
Material Handling Equip	4
Other General Industrial Equ	5
Sweeper/Scrubber	6
Tractor/Loader/Backhoe	7
Yard Tractor offroad	8
Yard Tractor onroad	9

Yard	Equipment Type			Model Year		Population	HP		Yearly Operational Hrs		Emission Control Factor? (y/n)	Emission Control
Commerce	Forklift			1993		2	150		1152		n	
Commerce	Forklift			1995		1	150		1152		n	
Commerce	Crane			1987		2	300		2448		n	
Commerce	Crane			1991		1	300		2448		n	
Commerce	Crane			1996		1	300		2448		n	
Commerce	Crane			1997		1	300		2448		n	
Commerce	Crane			2000		1	300		2448		n	
Commerce	Crane			2003		2	300		2448		n	
Commerce	Crane			2004		1	300		2448		n	
Commerce	Material Handling Equip			1986		1	250		60		n	
Commerce	Forklift			1975		1	150		365		n	
Commerce	Yard Tractor offroad			1999		2	150		4680		n	
Commerce	Yard Tractor offroad			1999		1	150		4680		n	
Commerce	Yard Tractor offroad			2000		2	150		4680		n	
Commerce	Yard Tractor offroad			2001		6	150		4680		n	
Commerce	Yard Tractor offroad			2002		3	150		4680		n	
Commerce	Yard Tractor offroad			2003		1	150		4680		n	
Commerce	Yard Tractor offroad			2004		8	150		4680		n	
Commerce	Yard Tractor offroad			2006		3	150		4680		n	
Commerce	Yard Tractor offroad			2000		3	150		4680		n	
Commerce	Crane			2000		1	200		150		n	
Commerce	Forklift			1995		3	60		365		n	
Commerce	Forklift			1995		1	240		365		n	
Commerce	Forklift			1989		1	66		365		n	
Commerce	Crane			1990		1	115		730		n	

APPENDIX E

EMISSION FACTOR DERIVATION AND OFFROAD2006
OUTPUT FOR HEAVY EQUIPMENT

Emission Factors for Diesel-Fueled Heavy Equipment
Commerce Rail Yard, Los Angeles, CA

Equipment Type	Make	Model	Year	Emission Factors (g/hp-hr)					VOC Evaporative Emissions	
				HC	CO	NOx	DPM	SOx	Part 1 (g/hr)	Part 2 (g/yr)
Crane	Loraine	RT-450	*2000*	0.5075	1.0873	6.8715	0.1684	0.0548	-	-
Fork Lift	Toyota	Unknown	*1995*	2.2319	5.2344	11.6880	1.2291	0.0571	-	-
Fork Lift	Caterpillar	Unknown	*1995*	1.9138	5.2917	14.4103	0.8102	0.0797	-	-
Fork Lift	Komatsu	Unknown	1989	0.2841	6.2313	13.7169	1.6357	0.0571	-	-
Trackmobile	Trackmobile	TM4000	*1990*	2.4075	5.5286	12.2868	1.3491	0.0571	-	-
Car Mover/Tug	NMC		1997	0.5143	1.0966	6.9240	0.1709	0.0548	-	-

Notes:
1. Emission factors from the OFFROAD2006 model.
2. Items in italics are engineering estimates.
3. Evaporative emissions are negligible.

Cnty	SubR	SCC	HP	TechType	MYr	Population	ROG-Exhaust	CO-Exhaust	NOx-Exhaust	CO2-Exhaust	SO2-Exhaust
Los Angeles		2270002045	250		2000		0.002815327	0.006032256	0.03812178	3.152798	0.000303851
Los Angeles		2270003020	120		1995		1.02E-02	2.40E-02	5.36E-02	2.61E+00	2.62E-04
Los Angeles							0.001853811	0.005125761	0.01395857	0.8005691	7.71548E-05
Los Angeles					1989		0.002191656	0.004831125	0.01063472	0.4406021	4.42699E-05
Los Angeles							0.0081354	0.01868243	0.0415196	1.920392	0.000192953
Los Angeles		2270002075	250		1997		0.002537619	0.005411169	0.0341664	2.804274	0.000270262

PM-Exhaust	Crankcase	FuelCons.	Activity	LF	HPAvg	ROG/ROG	ROG (lb/hp-hr)	CO (lb/hp-hr)	NOx (lb/hp-hr)	SOx (lb/hp-hr)	PM (lb/hp-hr)
0.000934			56.27074	0.43000001	208	1	0.001118779	0.002397151	0.015149167	0.000120747	0.000371161
5.63E-03			167.0114	0.3	83	1	0.004920516	0.011540025	0.025767738	0.000125885	0.002709668
0.000784823			1.43E+01	0.3	205	1	0.00421925	0.011666165	0.031769523	0.000175603	0.001786247
0.00126816			28.24655	0.3	83	1	0.006232146	0.013737684	0.030240662	0.000125885	0.003606113
0.004558844			6.20E+01	0.51	97	1	0.005307631	0.012188637	0.027087876	0.000125885	0.002974244
0.000843069			4.30E+01	0.65	160	1	0.001133751	0.002417589	0.015264779	0.000120747	0.000376664

CY	Season	AvgDays	Code	Equipment	Fuel	MaxHP	Class	C/R	Pre	Hand	Port	County	Air Basin	Air Dist.	MY	Population	Activity	Consumption	ROG Exhaust	CO Exhaust	NOX Exhaust	CO2 Exhaust	SO2 Exhaust	PM Exhaust	N2O Exhaust	CH4 Exhaust
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	2005	20	6.70E+01	3.39E+02	1.07E-03	6.18E-03	2.77E-02	3.75E+00	3.62E-04	6.17E-04	0.00E+00	9.68E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	2004	18	6.24E+01	3.16E+02	1.36E-03	5.94E-03	2.75E-02	3.50E+00	3.37E-04	6.14E-04	0.00E+00	1.22E-04
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	2003	17	5.74E+01	2.91E+02	1.74E-03	5.64E-03	2.83E-02	3.22E+00	3.10E-04	6.53E-04	0.00E+00	1.57E-04
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	2002	15	5.03E+01	2.56E+02	2.30E-03	5.09E-03	3.24E-02	2.82E+00	2.72E-04	7.54E-04	0.00E+00	2.07E-04
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	2001	14	4.84E+01	2.46E+02	2.31E-03	5.04E-03	3.19E-02	2.71E+00	2.61E-04	7.64E-04	0.00E+00	2.09E-04
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	2000	16	5.63E+01	2.86E+02	2.82E-03	6.03E-03	3.81E-02	3.15E+00	3.04E-04	9.34E-04	0.00E+00	2.54E-04
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1999	17	5.81E+01	2.95E+02	3.03E-03	6.40E-03	4.03E-02	3.25E+00	3.14E-04	1.01E-03	0.00E+00	2.74E-04
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1998	16	5.57E+01	2.83E+02	3.03E-03	6.30E-03	3.96E-02	3.12E+00	3.01E-04	1.01E-03	0.00E+00	2.73E-04
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1997	15	5.02E+01	2.55E+02	2.84E-03	5.84E-03	3.66E-02	2.81E+00	2.71E-04	9.56E-04	0.00E+00	2.57E-04
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1996	6	2.14E+01	1.09E+02	1.26E-03	2.56E-03	1.60E-02	1.20E+00	1.16E-04	4.25E-04	0.00E+00	1.14E-04
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1995	4	1.43E+01	7.35E+01	1.85E-03	5.13E-03	1.40E-02	8.01E-01	7.72E-05	7.85E-04	0.00E+00	1.67E-04
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1994	3	1.06E+01	5.44E+01	1.42E-03	3.89E-03	1.06E-02	5.93E-01	5.71E-05	6.08E-04	0.00E+00	1.28E-04
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1993	2	5.92E+00	3.05E+01	8.24E-04	2.23E-03	6.04E-03	3.32E-01	3.20E-05	3.56E-04	0.00E+00	7.43E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1992	1	4.69E+00	2.42E+01	6.75E-04	1.81E-03	4.89E-03	2.63E-01	2.53E-05	2.94E-04	0.00E+00	6.09E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1991	1	3.35E+00	1.73E+01	4.98E-04	1.32E-03	3.57E-03	1.88E-01	1.81E-05	2.18E-04	0.00E+00	4.49E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1990	1	2.96E+00	1.53E+01	4.53E-04	1.19E-03	3.21E-03	1.66E-01	1.60E-05	2.00E-04	0.00E+00	4.09E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1989	1	1.78E+00	9.17E+00	2.80E-04	7.31E-04	1.97E-03	9.95E-02	9.59E-06	1.25E-04	0.00E+00	2.53E-05
2005	Annual	Mon-Sun	2270002045	Cranes	D	250	Construction and Mining Equipment	U	N	NHH	P	Los Angeles	SC	SC	1988	0	5.92E-01	3.06E+00	9.62E-05	2.49E-04	6.68E-04	3.32E-02	3.20E-06	4.31E-05	0.00E+00	8.68E-06
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2005	35	1.70E+02	2.42E+02	1.72E-03	1.50E-02	2.35E-02	2.66E+00	2.67E-04	1.19E-03	0.00E+00	1.55E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2004	34	1.66E+02	2.37E+02	3.02E-03	1.58E-02	2.56E-02	2.60E+00	2.61E-04	1.75E-03	0.00E+00	2.73E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2003	34	1.69E+02	2.43E+02	6.68E-03	1.81E-02	3.36E-02	2.64E+00	2.65E-04	3.50E-03	0.00E+00	6.03E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2002	39	1.90E+02	2.74E+02	8.04E-03	2.13E-02	3.92E-02	2.97E+00	2.99E-04	4.32E-03	0.00E+00	7.25E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2001	38	1.88E+02	2.71E+02	8.46E-03	2.19E-02	4.01E-02	2.94E+00	2.95E-04	4.66E-03	0.00E+00	7.63E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	2000	44	2.17E+02	3.12E+02	1.03E-02	2.62E-02	4.78E-02	3.38E+00	3.40E-04	5.80E-03	0.00E+00	9.32E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1999	43	2.10E+02	3.03E+02	1.06E-02	2.64E-02	4.80E-02	3.28E+00	3.29E-04	6.05E-03	0.00E+00	9.55E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1998	42	2.05E+02	2.96E+02	1.09E-02	2.67E-02	4.84E-02	3.20E+00	3.22E-04	6.33E-03	0.00E+00	9.83E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1997	40	1.96E+02	2.83E+02	1.10E-02	2.64E-02	5.93E-02	3.06E+00	3.07E-04	5.89E-03	0.00E+00	9.88E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1996	39	1.92E+02	2.78E+02	1.13E-02	2.67E-02	5.99E-02	3.00E+00	3.01E-04	6.13E-03	0.00E+00	1.02E-03
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1995	34	1.67E+02	2.42E+02	1.02E-02	2.40E-02	5.36E-02	2.61E+00	2.62E-04	5.63E-03	0.00E+00	9.23E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1994	27	1.35E+02	1.96E+02	8.64E-03	2.00E-02	4.46E-02	2.11E+00	2.12E-04	4.80E-03	0.00E+00	7.79E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1993	8	3.72E+01	5.40E+01	2.48E-03	5.68E-03	1.26E-02	5.80E-01	5.83E-05	1.39E-03	0.00E+00	2.24E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1992	5	2.64E+01	3.84E+01	1.83E-03	4.15E-03	9.20E-03	4.12E-01	4.14E-05	1.04E-03	0.00E+00	1.65E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1991	5	2.30E+01	3.35E+01	1.66E-03	3.73E-03	8.24E-03	3.59E-01	3.61E-05	9.48E-04	0.00E+00	1.50E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1990	7	3.57E+01	5.21E+01	2.68E-03	5.95E-03	1.31E-02	5.58E-01	5.60E-05	1.54E-03	0.00E+00	2.41E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1989	6	2.82E+01	4.12E+01	2.19E-03	4.83E-03	1.06E-02	4.41E-01	4.43E-05	1.27E-03	0.00E+00	1.98E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1988	5	2.47E+01	3.61E+01	1.98E-03	4.34E-03	9.53E-03	3.86E-01	3.87E-05	1.16E-03	0.00E+00	1.79E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1987	4	2.00E+01	2.97E+01	2.42E-03	4.96E-03	1.18E-02	3.12E-01	3.14E-05	1.18E-03	0.00E+00	2.18E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1986	3	1.45E+01	2.16E+01	1.81E-03	3.69E-03	8.73E-03	2.26E-01	2.27E-05	8.92E-04	0.00E+00	1.63E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1985	2	1.08E+01	1.61E+01	1.39E-03	2.81E-03	6.64E-03	1.68E-01	1.69E-05	6.87E-04	0.00E+00	1.25E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1984	2	7.45E+00	1.11E+01	9.89E-04	1.99E-03	4.69E-03	1.16E-01	1.17E-05	4.92E-04	0.00E+00	8.92E-05
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1983	1	3.92E+00	5.86E+00	5.36E-04	1.07E-03	2.52E-03	6.12E-02	6.15E-06	2.68E-04	0.00E+00	4.83E-05
2005	Annual	Mon-Sun	2270003020	Forklifts	D	120	Industrial Equipment	U	P	NHH	NP	Los Angeles	SC	SC	1982	0	1.31E+00	1.96E+00	1.84E-04	3.65E-04	8.59E-04	2.04E-02	2.05E-06	9.22E-05	0.00E+00	1.66E-05
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2005	34	1.70E+02	5.92E+02	1.96E-03	1.09E-02	4.85E-02	6.55E+00	6.31E-04	1.09E-03	0.00E+00	1.77E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2004	34	1.66E+02	5.79E+02	2.74E-03	1.11E-02	5.10E-02	6.40E+00	6.17E-04	1.17E-03	0.00E+00	2.47E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2003	34	1.69E+02	5.89E+02	3.91E-03	1.18E-02	5.87E-02	6.50E+00	6.27E-04	1.40E-03	0.00E+00	3.53E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2002	39	1.90E+02	6.64E+02	6.40E-03	1.38E-02	8.75E-02	7.32E+00	7.06E-04	2.12E-03	0.00E+00	5.78E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2001	38	1.88E+02	6.56E+02	6.73E-03	1.42E-02	8.96E-02	7.23E+00	6.97E-04	2.24E-03	0.00E+00	6.08E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2000	44	2.16E+02	7.55E+02	8.22E-03	1.70E-02	1.07E-01	8.33E+00	8.03E-04	2.76E-03	0.00E+00	7.42E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1999	42	2.10E+02	7.33E+02	8.43E-03	1.71E-02	1.07E-01	8.07E+00	7.78E-04	2.84E-03	0.00E+00	7.60E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1998	42	2.05E+02	7.16E+02	8.68E-03	1.73E-02	1.08E-01	7.89E+00	7.60E-04	2.94E-03	0.00E+00	7.83E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1997	40	1.96E+02	6.85E+02	8.72E-03	1.71E-02	1.07E-01	7.54E+00	7.27E-04	2.96E-03	0.00E+00	7.87E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1996	39	1.92E+02	6.71E+02	8.96E-03	1.74E-02	1.08E-01	7.39E+00	7.12E-04	3.06E-03	0.00E+00	8.08E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1995	34	1.67E+02	5.91E+02	1.73E-02	4.57E-02	1.23E-01	6.42E+00	6.19E-04	7.64E-03	0.00E+00	1.56E-03
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1994	27	1.35E+02	4.78E+02	1.46E-02	3.81E-02	1.03E-01	5.19E+00	5.00E-04	6.51E-03	0.00E+00	1.32E-03
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1993	8	3.71E+01	1.32E+02	4.20E-03	1.08E-02	2.91E-02	1.43E+00	1.38E-04	1.89E-03	0.00E+00	3.79E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1992	5	2.63E+01	9.36E+01	3.10E-03	7.92E-03	2.12E-02	1.01E+00	9.78E-05	1.41E-03	0.00E+00	2.80E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1991	5	2.30E+01	8.18E+01	2.81E-03	7.11E-03	1.90E-02	8.85E-01	8.53E-05	1.29E-03	0.00E+00	2.54E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1990	7	3.57E+01	1.27E+02	4.53E-03	1.13E-02	3.02E-02	1.37E+00	1.32E-04	2.08E-03	0.00E+00	4.09E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1989	6	2.82E+01	1.00E+02	3.71E-03	9.21E-03	2.45E-02	1.09E+00	1.05E-04	1.72E-03	0.00E+00	3.35E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1988	5	2.47E+01	8.80E+01	3.36E-03	8.27E-03	2.20E-02	9.50E-01	9.15E-05	1.57E-03	0.00E+00	3.03E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1987	4	2.00E+01	7.21E+01	3.64E-03	1.07E-02	2.45E-02	7.69E-01	7.41E-05	1.91E-03	0.00E+00	3.28E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1986	3	1.45E+01	5.24E+01	2.73E-03	7.95E-03	1.82E-02	5.58E-01	5.38E-05	1.44E-03	0.00E+00	2.46E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1985	2	1.08E+01	3.90E+01	2.09E-03	6.05E-03	1.38E-02	4.15E-01	4.00E-05	1.11E-03	0.00E+00	1.89E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1984	2	7.44E+00	2.70E+01	1.59E-03	4.39E-03	9.76E-03	2.86E-01	2.76E-05	7.93E-04	0.00E+00	1.44E-04
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1983	1	3.91E+00	1.42E+01	8.62E-04	2.37E-03	5.25E-03	1.51E-01	1.45E-05	4.32E-04	0.00E+00	7.78E-05
2005	Annual	Mon-Sun	2270003020	Forklifts	D	250	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1982	0	1.30E+00	4.75E+00	2.96E-04	8.07E-04	1.79E-03	5.03E-02	4.84E-06	1.49E-04	0.00E+00	2.67E-05
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2005	26	1.00E+02	2.83E+02	1.98E-03	1.75E-02	2.73E-02	3.10E+00	3.12E-04	1.37E-03	0.00E+00	1.78E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2004	26	1.00E+02	2.83E+02	3.49E-03	1.86E-02	3.03E-02	3.10E+00	3.11E-04	2.02E-03	0.00E+00	3.14E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2003	25	9.91E+01	2.82E+02	7.50E-03	2.06E-02	3.83E-02	3.07E+00	3.09E-04	3.86E-03	0.00E+00	6.76E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2002	25	9.75E+01	2.78E+02	7.79E-03	2.10E-02	3.88E-02	3.02E+00	3.04E-04	4.11E-03	0.00E+00	7.03E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2001	25	9.62E+01	2.75E+02	8.10E-03	2.14E-02	3.94E-02	2.98E+00	3.00E-04	4.37E-03	0.00E+00	7.31E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	2000	30	1.16E+02	3.32E+02	1.03E-02	2.67E-02	4.91E-02	3.61E+00	3.62E-04	5.65E-03	0.00E+00	9.29E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1999	29	1.14E+02	3.26E+02	1.06E-02	2.70E-02	4.94E-02	3.54E+00	3.55E-04	5.91E-03	0.00E+00	9.55E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1998	29	1.11E+02	3.19E+02	1.08E-02	2.72E-02	4.96E-02	3.45E+00	3.47E-04	6.12E-03	0.00E+00	9.75E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1997	28	1.09E+02	3.13E+02	1.11E-02	2.74E-02	6.20E-02	3.38E+00	3.40E-04	5.79E-03	0.00E+00	9.98E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1996	28	1.08E+02	3.10E+02	1.14E-02	2.80E-02	6.31E-02	3.35E+00	3.37E-04	6.06E-03	0.00E+00	1.03E-03
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1995	24	9.44E+01	2.71E+02	1.04E-02	2.51E-02	5.63E-02	2.92E+00	2.94E-04	5.56E-03	0.00E+00	9.36E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1994	16	6.07E+01	1.74E+02	6.92E-03	1.65E-02	3.71E-02	1.88E+00	1.89E-04	3.75E-03	0.00E+00	6.25E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1993	9	3.70E+01	1.06E+02	4.38E-03	1.04E-02	2.32E-02	1.15E+00	1.15E-04	2.40E-03	0.00E+00	3.95E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1992	10	3.71E+01	1.07E+02	4.56E-03	1.07E-02	2.38E-02	1.15E+00	1.16E-04	2.52E-03	0.00E+00	4.11E-04

CY	Season	AvgDays	Code	Equipment	Fuel	MaxHP	Class	C/R	Pre	Hand	Port	County	Air Basin	Air Dist.	MY	Population	Activity	Consumption	ROG Exhaust	CO Exhaust	NOX Exhaust	CO2 Exhaust	SO2 Exhaust	PM Exhaust	N2O Exhaust	CH4 Exhaust
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1991	9	3.49E+01	1.00E+02	4.43E-03	1.03E-02	2.29E-02	1.08E+00	1.09E-04	2.46E-03	0.00E+00	4.00E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1990	16	6.20E+01	1.79E+02	8.14E-03	1.87E-02	4.15E-02	1.92E+00	1.93E-04	4.56E-03	0.00E+00	7.34E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1989	9	3.66E+01	1.06E+02	4.97E-03	1.13E-02	2.51E-02	1.14E+00	1.14E-04	2.80E-03	0.00E+00	4.48E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1988	6	2.49E+01	7.18E+01	3.48E-03	7.86E-03	1.74E-02	7.71E-01	7.74E-05	1.98E-03	0.00E+00	3.14E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1987	5	2.15E+01	6.29E+01	4.50E-03	9.53E-03	2.28E-02	6.65E-01	6.68E-05	2.15E-03	0.00E+00	4.06E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1986	5	1.92E+01	5.63E+01	4.14E-03	8.71E-03	2.08E-02	5.94E-01	5.97E-05	1.99E-03	0.00E+00	3.73E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1985	4	1.75E+01	5.14E+01	3.88E-03	8.11E-03	1.93E-02	5.41E-01	5.44E-05	1.88E-03	0.00E+00	3.50E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1984	4	1.48E+01	4.36E+01	3.38E-03	7.02E-03	1.67E-02	4.59E-01	4.61E-05	1.64E-03	0.00E+00	3.05E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1983	3	1.31E+01	3.86E+01	3.07E-03	6.34E-03	1.50E-02	4.06E-01	4.08E-05	1.50E-03	0.00E+00	2.77E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1982	3	1.16E+01	3.42E+01	2.79E-03	5.72E-03	1.36E-02	3.59E-01	3.61E-05	1.37E-03	0.00E+00	2.52E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1981	3	9.87E+00	2.92E+01	2.44E-03	4.97E-03	1.18E-02	3.06E-01	3.07E-05	1.20E-03	0.00E+00	2.20E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1980	2	7.97E+00	2.36E+01	2.02E-03	4.09E-03	9.68E-03	2.47E-01	2.48E-05	9.98E-04	0.00E+00	1.82E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1979	2	6.46E+00	1.91E+01	1.67E-03	3.38E-03	7.98E-03	2.00E-01	2.01E-05	8.31E-04	0.00E+00	1.51E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1978	1	4.75E+00	1.41E+01	1.26E-03	2.53E-03	5.97E-03	1.47E-01	1.48E-05	6.28E-04	0.00E+00	1.14E-04
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1977	1	3.80E+00	1.13E+01	1.03E-03	2.06E-03	4.86E-03	1.18E-01	1.18E-05	5.16E-04	0.00E+00	9.31E-05
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1976	1	2.66E+00	7.90E+00	7.39E-04	1.47E-03	3.46E-03	8.24E-02	8.28E-06	3.71E-04	0.00E+00	6.67E-05
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1975	0	1.42E+00	4.24E+00	4.05E-04	8.01E-04	1.88E-03	4.41E-02	4.43E-06	2.04E-04	0.00E+00	3.65E-05
2005	Annual	Mon-Sun	2270003040	Other General Industrial Equipmen	D	120	Industrial Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1974	0	4.75E-01	1.42E+00	1.38E-04	2.72E-04	6.38E-04	1.47E-02	1.48E-06	6.96E-05	0.00E+00	1.24E-05
2005	Annual	Mon-Sun	2270002075	Off-Highway Tractors	D	250	Construction and Mining Equipment	U	N	NHH	NP	Los Angeles	SC	SC	1997	18	4.30E+01	2.54E+02	2.54E-03	5.41E-03	3.42E-02	2.80E+00	2.70E-04	8.43E-04	0.00E+00	2.29E-04

APPENDIX F

TANKS OUTPUT AND SPECIATE DATABASE
SECTIONS FOR THE GASOLINE STORAGE TANK

TANKS 4.0
Emissions Report - Detail Format
Tank Identification and Physical Characteristics

Identification

User Identification:	Commerce TNKG-0100
City:	Los Angeles C.O.
State:	California
Company:	UPRR
Type of Tank:	Horizontal Tank
Description:	Loco Shop

Tank Dimensions

Shell Length (ft):	11.00
Diameter (ft):	4.00
Volume (gallons):	1,000.00
Turnovers:	10.00
Net Throughput (gal/yr):	10,000.00
Is Tank Heated (y/n):	N
Is Tank Underground (y/n):	N

Paint Characteristics

Shell Color/Shade:	White/White
Shell Condition:	Good

Breather Vent Settings

Vacuum Settings (psig):	-0.03
Pressure Settings (psig):	0.03

Meteorological Data used in Emissions Calculations: Los Angeles C.O., California (Avg Atmospheric Pressure = 14.67 psia)

TANKS 4.0
Emissions Report - Detail Format
Liquid Contents of Storage Tank

Mixture/Component	Month	Daily Liquid Surf. Temperatures (deg F) Avg.	Min.	Max.	Liquid Bulk Temp. (deg F)	Vapor Pressures (psia) Avg.	Min.	Max.	Vapor Mol. Weight	Liquid Mass Fract.	Vapor Mass Fract.	Mol. Weight	Basis for Vapor Pressure Calculations
Gasoline (RVP 10)	All	68.08	62.92	73.24	65.99	6.0512	5.4862	6.6617	66.0000			92.00	Option 4: RVP=10, ASTM Slope=3

TANKS 4.0
Emissions Report - Detail Format
Detail Calculations (AP-42)

Annual Emission Calculations	
Standing Losses (lb):	232.6371
Vapor Space Volume (cu ft):	88.0446
Vapor Density (lb/cu ft):	0.0705
Vapor Space Expansion Factor:	0.1685
Vented Vapor Saturation Factor:	0.6092
Tank Vapor Space Volume	
Vapor Space Volume (cu ft):	88.0446
Tank Diameter (ft):	4.0000
Effective Diameter (ft):	7.4867
Vapor Space Outage (ft):	2.0000
Tank Shell Length (ft):	11.0000
Vapor Density	
Vapor Density (lb/cu ft):	0.0705
Vapor Molecular Weight (lb/lb-mole):	66.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	6.0512
Daily Avg. Liquid Surface Temp. (deg. R):	527.7526
Daily Average Ambient Temp. (deg. F):	65.9667
Ideal Gas Constant R (psia cuft / (lb-mol-deg R)):	10.731
Liquid Bulk Temperature (deg. R):	525.6567
Tank Paint Solar Absorptance (Shell):	0.1700
Daily Total Solar Insulation Factor (Btu/sqft day):	1,567.1816
Vapor Space Expansion Factor	
Vapor Space Expansion Factor:	0.1685
Daily Vapor Temperature Range (deg. R):	20.6478
Daily Vapor Pressure Range (psia):	1.1755
Breather Vent Press. Setting Range(psia):	0.0600
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	6.0512
Vapor Pressure at Daily Minimum Liquid Surface Temperature (psia):	5.4862
Vapor Pressure at Daily Maximum Liquid Surface Temperature (psia):	6.6617
Daily Avg. Liquid Surface Temp. (deg R):	527.7526
Daily Min. Liquid Surface Temp. (deg R):	522.5906
Daily Max. Liquid Surface Temp. (deg R):	532.9145
Daily Ambient Temp. Range (deg. R):	18.3167
Vented Vapor Saturation Factor	
Vented Vapor Saturation Factor:	0.6092
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	6.0512
Vapor Space Outage (ft):	2.0000
Working Losses (lb):	95.0904
Vapor Molecular Weight (lb/lb-mole):	66.0000
Vapor Pressure at Daily Average Liquid Surface Temperature (psia):	6.0512
Annual Net Throughput (gal/yr.):	10,000.0000
Annual Turnovers:	10.0000
Turnover Factor:	1.0000
Tank Diameter (ft):	4.0000
Working Loss Product Factor:	1.0000
Total Losses (lb):	327.7275

TANKS 4.0
Emissions Report - Detail Format
Individual Tank Emission Totals

Annual Emissions Report

	Losses(lbs)		
Components	Working Loss	Breathing Loss	Total Emissions
Gasoline (RVP 10)	95.09	232.64	327.73

Exerpts from CARB's SPECIATE Database

ORGPROF	SAROAD	ORGPROFN	ORGFRAC	CAS	CHEM_NAME
419	45208	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0187	95636	1,2,4-trimethylbenzene
419	43276	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0545	540841	2,2,4-trimethylpentane
419	91123	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0014	91576	2-methylnaphthalene
419	45201	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.01	71432	benzene
419	43248	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0022	110827	cyclohexane
419	45203	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0215	100414	ethylbenzene
419	43243	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0001	78795	isoprene
419	98043	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0006	98828	isopropylbenzene (cumene)
419	43301	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0001	67561	methyl alcohol
419	43378	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.11549998	1634044	methyl t-butyl ether (mtbe)
419	45205	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0353	108383	m-xylene
419	98046	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0018	91203	naphthalene
419	43231	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0119	110543	n-hexane
419	45204	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.02099998	95476	o-xylene
419	45206	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0182	106423	p-xylene
419	45202	Liquid gasoline - MTBE 11% - Commercial grade - MTBE/EtOH program	0.0669	108883	toluene

APPENDIX G

EMISSION FACTOR DERIVATION AND OFFROAD2006 OUTPUT FOR TRUs AND REEFER CARS

Emission Factors for Transport Refrigeration Units and Refrigerated Railcars
Commerce Rail Yard, Los Angeles, CA

TRU Equip Type	Average Rating (hp)[1]	Fuel Type	Emission Factors (g/hp-hr)					VOC Evaporative Emission Factors	
			HC	CO	NOx	DPM	SOx	Part 1 (g/hr)	Part 2 (g/yr)
Container	28.56	Diesel	2.85	6.78	6.43	0.71	0.07	-	-
Railcar	34	Diesel	3.23	7.49	6.71	0.79	0.07	-	-
Total									

Notes:
1. Based on the average horsepower distribution in the OFFROAD2006 model.
2. Emission factors from OFFROAD2006 model.
3. Evaporative emissions are negligible.

CY	Season	AvgDays	Code	Equipment	Fuel	MaxHP	Class	C/R	Pre
2005	Annual	Mon-Sun	2.27E+09	Transport Refrigeration Units	D	15	Transport Refrigeration Units	U	N
2005	Annual	Mon-Sun	2.27E+09	Transport Refrigeration Units	D	25	Transport Refrigeration Units	U	N
2005	Annual	Mon-Sun	2.27E+09	Transport Refrigeration Units	D	50	Transport Refrigeration Units	U	N

Hand	Port	County	Air Basin	Air Dist.	Population	Activity	Consumption	ROG Exhaust	CO Exhaust	NOX Exhaust
NHH	NP	Los Angeles	SC	SC	1.15E+03	3.27E+03	1.20E+03	2.07E-02	8.80E-02	1.44E-01
NHH	NP	Los Angeles	SC	SC	4.49E+02	1.28E+03	7.96E+02	1.32E-02	4.58E-02	8.56E-02
NHH	NP	Los Angeles	SC	SC	8.18E+03	3.29E+04	3.98E+04	2.11E+00	4.89E+00	4.38E+00
								ROG Exhaust	CO Exhaust	NOX Exhaust
						0-15	lb/hr	1.26E-02	5.38E-02	8.79E-02
						15-25	lb/hr	2.06E-02	7.16E-02	1.34E-01
						25-50	lb/hr	1.28E-01	2.97E-01	2.67E-01
						container	lb/hr	0.100144986	0.237934225	0.225580552
						rail	lb/hr	0.128462617	0.297410608	0.266558642
						container	lb/hp-hr	0.006289645	0.014943552	0.014167675
						rail	lb/hp-hr	0.007128891	0.016504473	0.014792377
						0-15	lb/hp-hr	0.001974637	0.008409021	0.013736294
						15-25	lb/hp-hr	0.001895241	0.006580025	0.012312135
						25-50	lb/hp-hr	0.007128891	0.016504473	0.014792377

CO2 Exhaust	SO2 Exhaust	PM Exhaust	N2O Exhaust	CH4 Exhaust	
1.31E+01	1.42E-03	9.22E-03	0.00E+00	1.86E-03	
8.71E+00	9.47E-04	5.41E-03	0.00E+00	1.19E-03	
4.26E+02	4.71E-02	5.13E-01	0.00E+00	1.90E-01	
CO2 Exhaust	SO2 Exhaust	PM Exhaust	load	avg hp	container
8.02E+00	8.71E-04	5.64E-03	0.64	10	0.17
1.36E+01	1.48E-03	8.46E-03	0.64	17	0.08
2.59E+01	2.87E-03	3.12E-02	0.53	34	0.75
21.87652896	0.002417326	0.025063786	0.5575	28.56	
25.89716742	0.002867557	0.031237629	0.53	34	
1.37396396	0.000151821	0.001574141			
1.437134707	0.000159132	0.001733498			
1.252887439	0.000136161	0.000881526			
1.252885877	0.000136161	0.000777189			
1.437134707	0.000159132	0.001733498			

APPENDIX H

DETAILED EMISSION CALCULATIONS

Summary of Diesel Particulate Matter Emissions
Commerce Rail Yard, Los Angeles, CA

Source	DPM Emissions (tpy)
Locomotives	4.87
On-Road Diesel-Fueled Trucks	0.02
HHD Diesel-Fueled Trucks	1.99
Cargo Handling Equipment (CHE)	3.94
Heavy Equipment	0.14
Transport Refrigeration Units (TRUs)	0.27
Total	**11.23**

Summary of Toxic Air Contaminant Emissions
Commerce Rail Yard, Los Angeles, CA

CAS	Chemical Name	Emissions (tpy)		
		Gasoline Storage Tank	WWTP	Total
540841	2,2,4-trimethylpentane	0.002	-	0.002
71432	Benzene	0.001	0.000	0.001
	Bis(2-ethylhexyl) Phthalate	-	0.000	0.000
	Bromomethane	-	0.000	0.000
67663	Chloroform	-	0.000	0.000
110827	Cyclohexane	0.002	-	0.002
100414	Ethylbenzene	0.000	0.000	0.000
78784	isopentane	0.061	-	0.061
98828	Isopropylbenzene (cumene)	0.000	-	0.000
108383	m-xylene	0.001	-	0.001
110543	n-hexane	0.003	-	0.003
95476	o-xylene	0.000	-	0.000
106423	p-xylene	0.000	-	0.000
108883	Toluene	0.003	0.000	0.003
1330207	Xylene (total)	0.001	0.001	0.002
Total		**0.072**	**0.001**	**0.073**

Summary of Diesel Particulate Emissions from Locomotives
Commerce Rail Yard, Los Angeles, CA

Activity	DPM Emissions (tpy)
Through Trains	0.36
Intermodal Trains	0.49
Other Trains	0.36
Power Moves	0.07
Yard Operations	1.90
Service and Shop Idling	1.38
Load Test	0.32
Total	**4.87**

Summary of Emissions from On-Road Diesel-Fueled Trucks
Commerce Rail Yard, Los Angeles, CA

Running Exhaust Emissions

Equipment Type	Equip. ID	Make	Model	Model Year	Vehicle Class	Annual VMT [1]	Emission Factors (g/mi)[2] ROG	CO	NOx	DPM	SOx	Emissions (tpy) ROG	CO	NOx	DPM	SOx
Pickup	ITS-950	Ford	F150	1996	LDT	14,000	0.11	1.11	1.62	0.07	0.04	0.002	0.017	0.025	0.001	0.001
Pickup	ITS-2027	Ford	F250	2000	MDV	15,000	0.13	1.13	0.48	0.13	0.00	0.002	0.019	0.008	0.002	0.000
Pickup	ITS-2018	Ford	F250	2002	MDV	22,000	0.10	1.16	1.64	0.10	0.00	0.002	0.028	0.040	0.002	0.000
Pickup	ITS-2048	Ford	F250	2002	MDV	24,000	0.10	1.16	1.64	0.10	0.00	0.003	0.031	0.043	0.003	0.000
Pickup	UP-19939	Ford	F350	2002	LHDT1	43,000	0.35	1.76	6.73	0.09	0.05	0.016	0.084	0.319	0.004	0.002
Pickup	ITS-2145	Ford	F350	2002	LHDT1	22,000	0.35	1.76	6.73	0.09	0.05	0.008	0.043	0.163	0.002	0.001
Pickup	ITS-2141	Ford	F350	2005	LHDT1	38,000	0.22	1.45	5.73	0.06	0.06	0.009	0.061	0.240	0.002	0.002
Total												**0.043**	**0.282**	**0.838**	**0.017**	**0.006**

Idling Exhaust Emissions

Equipment Type	Equip. ID	Make	Model	Model Year	Vehicle Class	Idling [1] (min/day)	(hr/yr)	Emission Factors (g/hr)[2] ROG	CO	NOx	DPM	SOx	Emissions (tpy) ROG	CO	NOx	DPM	SOx
Pickup	ITS-950	Ford	F150	1996	LDT	15	91	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pickup	ITS-2027	Ford	F250	2000	MDV	15	91	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pickup	ITS-2018	Ford	F250	2002	MDV	15	91	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pickup	ITS-2048	Ford	F250	2002	MDV	15	91	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Pickup	UP-19939	Ford	F350	2002	LHDT1	15	91	3.173	26.300	75.051	0.753	0.341	0.000	0.003	0.008	0.000	0.000
Pickup	ITS-2145	Ford	F350	2002	LHDT1	15	91	3.173	26.300	75.051	0.753	0.341	0.000	0.003	0.008	0.000	0.000
Pickup	ITS-2141	Ford	F350	2005	LHDT1	15	91	3.173	26.300	75.051	0.753	0.341	0.000	0.003	0.008	0.000	0.000
Total													**0.001**	**0.008**	**0.023**	**0.000**	**0.000**

Notes:
1. Annual VMT and idling time estimated by UPRR and ITS personnel based on the current vehicle odometer readings and the age of the vehicle.
2. Running exhaust emissions calculated using the EMFAC-WD 2006 model with the BURDEN output option.
3. Idling exhaust emissions for LHDT1 vehicles calculated using the EMFAC-WD 2006 model with the EMFAC output option.

Summary of Emissions from Intermodal HHD Diesel-Fueled Truck Traffic
Commerce Rail Yard, Los Angeles, CA

Running Exhaust Emissions

Number of Truck Trips	VMT per Trip	VMT per Year	Emission Factors (g/mi)					Emissions (tpy)				
			ROG	CO	NOx	DPM	SOx	ROG	CO	NOx	DPM	SOx
374,435	1.5	561,652.50	5.73	15.40	27.41	2.27	0.24	3.55	9.54	16.97	1.41	0.15

Idling Exhaust Emissions

Number of Truck Trips	Idling		Emission Factors (g/hr)					Emissions (tpy)				
	(mins/trip)	(hr/yr)	ROG	CO	NOx	DPM	SOx	ROG	CO	NOx	DPM	SOx
374,435	30	187,217.50	16.163	52.988	100.382	2.845	0.550	3.34	10.94	20.72	0.59	0.11

Notes:
1. Number of truck trips calculated from UPRR provided gate counts. The total gate counts were increased by 25% to account for bobtail trucks (trucks without a chassis or trailer and trucks with an empty chassis).
2. VMT per trip from Trinity Report.
3. Running exhaust emission factors from EMFAC-WD 2006 using the BURDEN output option.
4. Idling exhaust emission factors from EMFAC-WD 2006 using the EMFAC output option.
5. Emission factor calculations assumed an average speed of 15 mph.

Summary of Emissions from Diesel Fueled Cargo Handling Equipment
Commerce Rail Yard, Los Angeles, CA

Equipment Type	Equipment ID	Make	Model	Year	Rating (hp)	No. of Units	Annual Hours of Operation	Load Factor	Emission Factors (g/bhp-hr)					Emission (tpy)				
									HC	CO	NOx	DPM	SOx	HC	CO	NOx	DPM	SOx
Chassis Stacker	69303	Taylor	TCS90	1993	150	2	1152	0.30	0.579	2.981	8.290	0.367	0.060	0.066	0.341	0.947	0.042	0.007
Chassis Stacker	69515	Taylor	TCS90	1995	150	1	1152	0.30	0.565	2.938	8.183	0.354	0.060	0.032	0.168	0.468	0.020	0.003
RTG	98716	Mi Jack	1000R	1987	300	2	2448	0.43	0.886	5.182	12.498	0.679	0.052	0.617	3.608	8.701	0.472	0.036
RTG	99119	Mi Jack	1000R	1991	300	1	2448	0.43	0.669	3.263	8.928	0.444	0.052	0.233	1.136	3.108	0.155	0.018
RTG	99636	Mi Jack	850R	1996	300	1	2448	0.43	0.287	1.048	6.616	0.169	0.052	0.100	0.365	2.303	0.059	0.018
RTG	99740	Mi Jack	850R	1997	300	1	2448	0.43	0.281	1.035	6.547	0.165	0.052	0.098	0.360	2.279	0.057	0.018
RTG	90082	Mi Jack	1000R	2000	300	1	2448	0.43	0.264	0.997	6.340	0.151	0.052	0.092	0.347	2.207	0.053	0.018
RTG	90393	Taylor	9040	2003	300	2	2448	0.43	0.093	0.958	4.209	0.101	0.052	0.065	0.667	2.931	0.070	0.036
RTG	90402	Mi Jack	1000RC	2004	300	1	2448	0.43	0.091	0.946	4.162	0.097	0.052	0.032	0.329	1.449	0.034	0.018
Top Pick	88646	Raygo	CH70	1986	250	1	60	0.59	0.943	5.367	12.617	0.720	0.060	0.009	0.052	0.123	0.007	0.001
Fork Lift	105	Lull	John Deere	1975	150	1	*365*	0.30	1.032	5.491	13.582	0.694	0.060	0.019	0.099	0.246	0.013	0.001
Yard Hostler	199510	Capacity	TJ5100	1999	150	2	4680	0.55	0.550	2.889	6.942	0.372	0.060	0.468	2.459	5.909	0.317	0.051
Yard Hostler	199519	Capacity	TJ5100	1999	150	1	4680	0.55	0.550	2.889	6.942	0.372	0.060	0.234	1.230	2.954	0.159	0.025
Yard Hostler	100560	Capacity	TJ5100	2000	150	2	4680	0.55	0.541	2.862	6.885	0.364	0.060	0.461	2.436	5.860	0.310	0.051
Yard Hostler	101619	Capacity	TJ5100	2001	150	6	4680	0.55	0.532	2.835	6.827	0.355	0.060	1.360	7.240	17.435	0.907	0.153
Yard Hostler	102733	Capacity	TJ5100	2002	150	3	4680	0.55	0.524	2.808	6.770	0.347	0.060	0.669	3.585	8.644	0.443	0.076
Yard Hostler	103770	Capacity	TJ5100	2003	150	1	4680	0.55	0.250	2.781	5.117	0.214	0.060	0.106	1.184	2.178	0.091	0.025
Yard Hostler	104778	Capacity	TJ5100	2004	150	8	4680	0.55	0.164	2.754	4.553	0.165	0.060	0.558	9.377	15.502	0.561	0.203
Yard Hostler	106916	Capacity	TJ5100	2006	150	3	4680	0.55	0.115	2.700	4.209	0.132	0.060	0.147	3.447	5.374	0.168	0.076
Totals						**40**								**5.36**	**38.43**	**88.62**	**3.94**	**0.84**

Notes:
1. Emission factors from CARB's Cargo Handling Equipment Emission Calculation Spreadsheet.
2. Hours of operation provided by UPRR personnel.
3. Items in italics are engineering estimates.

Summary of Emissions from Diesel-Fueled Heavy Equipment
Commerce Rail Yard, Los Angeles, CA

Equipment				Rating	No. of	Annual Hours	Load	Emission Factors (g/hp-hr)					VOC Evaporative Emissions		Emission (tpy)				
Type	Make	Model	Year	(hp)	Units	of Operation	Factor	HC	CO	NOx	DPM	SOx	Part 1 (g/hr)	Part 2 (g/yr)	HC	CO	NOx	DPM	SOx
Crane	Loraine	RT-450	*2000*	*200*	1	150	0.43	0.51	1.09	6.87	0.17	0.05	-	-	0.007	0.015	0.098	0.002	0.001
Fork Lift	Toyota	Unknown	*1995*	60	3	*365*	0.30	2.23	5.23	11.69	1.23	0.06	-	-	0.048	0.114	0.254	0.027	0.001
Fork Lift	Caterpillar	Unknown	*1995*	240	1	*365*	0.30	1.91	5.29	14.41	0.81	0.08	-	-	0.055	0.153	0.417	0.023	0.002
Fork Lift	Komatsu	Unknown	1989	66	1	*365*	0.30	0.28	6.23	13.72	1.64	0.06	-	-	0.002	0.050	0.109	0.013	0.000
Trackmobile	Trackmobile	TM4000	*1990*	*115*	1	*730*	0.51	2.41	5.53	12.29	1.35	0.06	-	-	0.114	0.261	0.580	0.064	0.003
Car Mover/Tug	NMC		1997	250	2	156	0.65	0.51	1.10	6.92	0.17	0.05	-	-	0.029	0.061	0.387	0.010	0.003
Totals					**9**										**0.26**	**0.65**	**1.85**	**0.14**	**0.01**

Notes:
1. Emission factors from the OFFROAD2006 model.
2. Hours of operation provided by UPRR personnel.
3. Items in italics are engineering estimates.
4. Information for Trackmobile based on similar model at Stockton Rail Yard.
5. Evaporative emissions are negligible.

Summary of Equipment Specifications and Emissions from Storage Tanks
Commerce Rail Yard, Los Angeles, CA

Tank No.	Tank Location	Material Stored	Tank Capacity	Tank Dimensions	Shell Color	Shell Condition	Annual Throughput (gal/yr)	VOC Emissions (tpy)	Permitted?	Citation
AST-1	Tractor Maintenance	Used Oil	1,000	10 x 4 (H)	Black	Good	36,000	NA	Exempt	Rule 219(n)(7)
AST-2	Tractor Maintenance	Hydraulic Oil	240	5 x 3.25 x 4 (H)	White	Good	960	NA	Exempt	Rule 219(n)(7)
AST-3	Tractor Maintenance	Motor Oil	500	8 x 3.25 x 4 (H)	White	Good	8,400	NA	Exempt	Rule 219(n)(7)
AST-4	Crane Maintenance	Motor Oil	350	6.5 x 3 x 3 (H)	White	Good	1,080	NA	Exempt	Rule 219(n)(7)
AST-5	Crane Maintenance	Hydraulic Oil	500	9 x 3 x 3 (H)	White	Good	1,200	NA	Exempt	Rule 219(n)(7)
AST-6	Tractor Maintenance	Diesel	500	6 x 3.75 (H)	White	Good	13,000	NA	Exempt	Rule 219(n)(4)
AST-8	Crane Maintenance	Used Oil	750	4 x 2 (H)	White	Good	1,080	NA	Exempt	Rule 219(n)(7)
AST-9	Northwest Services	Diesel	1,000	NA	Blue	Good	NA	NA	Exempt	Rule 219(n)(4)
TNKD-0118	Locomotive Shop	Diesel	1,000	11 x 5 x 6 (H)	White	Good	6,000	NA	Exempt	Rule 219(n)(4)
TNKD-1052	**Locomotive Shop**	**Diesel**	**420,000**	**32 x 47.5 (V)**	**White**	**Good**	**15,056,734**	**0.208**	**Yes**	**Rule 463**
TNKD-1111	WWTP	Diesel	8,000	27.5 x 8 (H)	White	Good	120,000	NA	Exempt	Rule 219(n)(4)
TNKD-1116	Crane Maintenance (UP Owned)	Diesel	2,000	11 x 5.5 x 8 (H)	White	Good	NA	NA	Exempt	Rule 219(n)(4)
TNKD-8601	**Locomotive Shop**	**Diesel**	**150,000**	**20 x 36 (V)**	**White**	**Good**	**5,018,911**	**0.069**	**Yes**	**Rule 463**
TNKG-0100	**Locomotive Shop**	**Gasoline**	**1,000**	**11 x 3 x 4 (H)**	**White**	**Good**	**10,000**	**0.164**	**Yes**	**Rule 461**
TNKO-0171	Locomotive Shop	Lube Oil	20,000	30 x 11 (H)	White	Good	446,185	NA	Exempt	Rule 219(n)(7)
TNKO-9201	WWTP	Recovered Oil	5,306	8.5 x 10.25 (V)	Fiber Glass	Good	36,900	NA	Exempt	Rule 219(n)(7)
TNKO-9202	WWTP	Recovered Oil	5,306	8.5 x 10.25 (V)	Fiber Glass	Good	36,900	NA	Exempt	Rule 219(n)(7)
TNKO-9203	Locomotive Shop	Used Lube Oil	10,000	27.5 x 7.5 (H)	White	Good	NA	NA	Exempt	Rule 219(n)(7)
Total								**0.441**		

Toxic Air Contaminant Emissions from the Gasoline Storage Tank TNKG-0100
Commerce Rail Yard, Los Angeles, CA

CAS	Chemical Name	Organic Fraction	Emissions (tpy)
540841	2,2,4-trimethylpentane	0.0129	0.0021
71432	benzene	0.0036	0.0006
110827	cyclohexane	0.0103	0.0017
100414	ethylbenzene	0.0012	0.0002
78784	isopentane	0.3734	0.0612
98828	isopropylbenzene (cumene)	0.0001	0.0000
108383	m-xylene	0.0034	0.0006
110543	n-hexane	0.0154	0.0025
95476	o-xylene	0.0013	0.0002
106423	p-xylene	0.0011	0.0002
108883	toluene	0.0170	0.0028
Total		**0.44**	**0.0720**

Notes:
1. Organic fraction from ARBs SPECIATE database. Data is from "Headspace vapors 1996 SSD etoh 2.0% (MTBE phaseout)" option.
2. Emissions were calculated for only chemicals that were in both the SPECIATE database and the AB2588 list.

Summary of Emissions from Sand Tower Operations
Commerce Rail Yard, Los Angeles, CA

Pollutant	2005 Sand Throughput (ton/yr)	Pneumatic Transfer Emission Factor (lb/ton)	Gravity Transfer Emission Factor (lb/ton)	Process Emissions (tpy)		
				Pneumatic Transfer	Gravity Transfer	Total
PM10	5258.00	0.00034	0.00099	0.0009	0.0026	0.0035

Notes:
1. Sand throughput provided by Union Pacific
2. Pneumatic transfer emission factor from AP-42, Table 11.12-2, 6/06. Factor for controlled pneumatic cement unloading to elevated storage silo was used. The unit is equipped with a fabric filter.
3. Gravity transfer emission factor from AP-42, Table 11.12-2, 6/06. Factor for sand transfer was used.
4. There are no TAC emissions from this source.

Toxic Air Contaminant Emissions from DAF, Oil/Water Separator, and Basins at Wastewater Treatment Plant
Commerce Rail Yard, Los Angeles, CA

Pollutant	Emission Rate (grams/sec)	Emissions (tpy)
Benzene	5.13E-07	4.73E-05
Bis(2-ethylhexyl) Phthalate	2.53E-08	2.33E-06
Bromomethane	9.00E-07	8.30E-05
Chloroform	6.30E-07	5.81E-05
Ethylbenzene	3.06E-06	2.82E-04
Methylene Chloride	1.08E-05	9.96E-04
Toluene	3.51E-06	3.24E-04
Xylene	6.30E-06	5.81E-04
Total	**2.57E-05**	**2.37E-03**

1. Emission rates are from the Air Emissions Inventory and Regulatory Analysis Report for Commerce Yard, Trinity Consultants, August 12, 2004.
2. Emission rates from USEPA's Water8 Program and are based on the 1999 wastewater flow rate of 793,875 gallons per year.
3. Emissions (lb/yr) were calculated multiplying the emission rate by the ratio of the 1999 wastewater flow rate and the 2005 wastewater flow rate.

tpy = Emission Rate (g/sec) x (3600 sec/hr) x (8760 hr/yr) x (1 lb/ 453.59 g) x (2,105,044 gal/yr / 793,875 gal/yr) x (1/2000)

4. The 2005 wastewater flow rate was provided by Mr. Duffy Exon of Union Pacific.

Summary of Emissions from Transport Refrigeration Units and Refrigerated Railcars
Commerce Rail Yard, Los Angeles, CA

TRU Equip Type	Average Rating (hp)[1]	Fuel Type	Average No. Units in Yard[2]	Hours of Operation		Load Factor[5]	Emission Factors (g/hp-hr)[6]					VOC Evaporative Emission Factors[6, 7]		Emissions (tpy)				
				(hr/day)[3]	(hr/yr)[4]		HC	CO	NOx	DPM	SOx	Part 1 (g/hr)	Part 2 (g/yr)	HC	CO	NOx	DPM	SOx
Container	28.56	Diesel	10	4	1,460	0.56	2.85	6.78	6.43	0.71	0.07	-	-	0.731	1.737	1.647	0.183	0.018
Railcar	34	Diesel	4	4	1,460	0.53	3.23	7.49	6.71	0.79	0.07	-	-	0.375	0.868	0.778	0.091	0.008
Total			**14**		**2,920**									**1.11**	**2.61**	**2.43**	**0.27**	**0.03**

Notes:
1. Based on the average horsepower distribution in the OFFROAD2006 model.
2. UPRR staff estimate that there are 3-5 TRUs and 0-2 reefer cars and in the Yard at any given time. To be conservative, these estimates were increased by 100%.
3. From CARB's Staff Report: ISOR, ATCM for TRUs, Section V.a.2.
4. It was assumed that the number of units and the annual hours of operations remains constant, with individual units cycling in and out of the yard.
5. Load factors are the default factors from the OFFROAD 2006 model.
6. Emission factors from OFFROAD2006 model.
7. Evaporative emissions are negligible.

Summary of Welding Equipment Specifications
Commerce Rail Yard, Los Angeles, CA

Location	Make	Serial No.	Fuel Type	Rating (hp)
WWTP	Miller Big 40	72/648520	Gasoline	40
UP Yard	Miller Big 40	HK321104	Gasoline	40
Crane Maintenance Area	Miller 250G	KE587338	Gasoline	20
Car Dept	Briggs and Straton	9602051A	Gasoline	11
Car Dept	Briggs and Straton	9602051A	Gasoline	11
Car Dept	Blue Start		Gasoline	20
Car Dept	Miller Bobcat 225D		Diesel	16
Car Dept	Lincoln G8000		Gasoline	20
Locomotive	Miller Bobcat		Gasoline	16

Notes:
1. Welding equipment is exempt from SCAQMD permitting requirements per Rule 219(f)(8).
2. IC Engines meet the exempt requirements of SCAQMD Rule 219(b)(1).

Summary of Equipment Specifications for Steam Cleaners
Commerce Rail Yard, Los Angeles, CA

Location	Make	Model	Serial No.	Emission Unit	Fuel Type	Rating (MMBtu/hr or hp)
UP Yard[1]	Hydroblaster	4/2000CLGV-P	11043	Pump	Electric	-
				Heater	Propane	0.325
UP Yard[1]	Hydroblaster	4/2000CLGV-P	11039	Pump	Electric	-
				Heater	Propane	0.325
UP Yard[1]	Hydroblaster	4/2000CLGV-P	11036	Pump	Electric	-
				Heater	Propane	0.325
UP Yard[1]	Hydroblaster	4/2000CLGV-P	12065	Pump	Electric	-
				Heater	Propane	0.325
Crane Maintenance [2]	Landa	DGHW5-30221E	P0798-9975	Pump	Gasoline	16
				Heater	Propane	0.35
Trailer Repair Shop [3]	Kohler	YKHXS 6242GC	3022710671	Pump	Gasoline	20
				Heater	Decommissioned	-

Notes:
1. These units are exempt from SCAQMD permitting requirements per Rule 219(e)(5) and (b)(2).
2. The heater in this unit is exempt from SCAQMD permitting requirements per Rule 219(b)(2). The pump is exempt from SCAQMD permitting requirements per Rule 219(b)(1).
3. The pump in this unit is exempt from SCAQMD permitting requirements per Rule 219(b)(1).
4. Hours of operation provided by UPRR.

Summary of Equipment Specifications for Miscellaneous Equipment
Commerce Rail Yard, Los Angeles, CA

Location	Equipment Type	Make	Serial No.	Fuel Type	Rating (hp)
UP Yard (Car Department)	Air Compressor	Ingersoll-Rand	120372U81928	Diesel	45
Crane Maintenance	Air Compressor	Perkins	RO66280EE	Diesel	34
UP Yard (Car Department)	Air Compressor	Briggs and Straton	Unknown	Gasoline	5
UP Yard (Car Department)	Air Compressor	Briggs and Straton	Unknown	Gasoline	5
WWTP	Emergency Pump	Multiquip	301TH-10827	Gasoline	8
WWTP	Vacuum	Unknown	Unknown	Gasoline	21
Car Shop	Jack	Portec	Unknown	Gasoline	11
Yard Office Building	Emergency Generator	Olympian	2038760	Propane	13

Notes:
1. These units are exempt from SCAQMD permitting requirements per Rule 219(b)(1).

APPENDIX I

DETAILED RISK SCREENING CALCULATIONS

Summary of Risk Index Values
Commerce Rail Yard, Los Angeles, CA

Source	Risk Index Value Cancer	% of Total Cancer Risk	Risk Index Value Chronic	% of Total Chronic Risk
Locomotives	1.46E-03	43.38	2.44E+01	31.43
WWTP	1.68E-09	0.00	1.09E+00	1.40
Gasoline Storage Tank	1.71E-08	0.00	2.03E+01	26.14
On-Road Diesel-Fueled Trucks	5.20E-06	0.15	8.66E-02	0.11
HHD Diesel-Fueled Trucks	5.98E-04	17.75	9.97E+00	12.86
Cargo Handling Equipment (CHE)	1.18E-03	35.04	1.97E+01	25.39
Heavy Equipment	4.16E-05	1.24	6.94E-01	0.90
Transport Refrigeration Units (TRUs)	8.23E-05	2.44	1.37E+00	1.77
Total	3.37E-03	100.00	7.75E+01	100.00
De Minimis Sources (% of Total)		3.83		4.18

Notes:
1. There are no TAC emissions from the sand tower or the Diesel fuel storage tanks.

Calculation of Risk Index Values for Diesel-Fueled Sources
Commerce Rail Yard, Los Angeles, CA

Source	DPM Emissions (tpy)	Unit Risk Factor Cancer	Cancer Risk Index Value	Unit Risk Factor Chronic	Chronic Risk Index Value
Locomotives	4.87	3.00E-04	1.46E-03	5.00E+00	2.44E+01
On-Road Diesel-Fueled Trucks	0.02	3.00E-04	5.20E-06	5.00E+00	8.66E-02
HHD Diesel-Fueled Trucks	1.99	3.00E-04	5.98E-04	5.00E+00	9.97E+00
Cargo Handling Equipment (CHE)	3.94	3.00E-04	1.18E-03	5.00E+00	1.97E+01
Heavy Equipment	0.14	3.00E-04	4.16E-05	5.00E+00	6.94E-01
Transport Refrigeration Units (TRUs)	0.27	3.00E-04	8.23E-05	5.00E+00	1.37E+00
Total	**11.23**		**3.37E-03**		**5.62E+01**

Notes:
1. Unit risk factor from Consolidated Table of OEHHA/ARB Approved Risk Assessment Health Values, April 25, 2005. Cancer inhalation risk used.

Summary of Toxic Air Contaminant Emissions
Commerce Rail Yard, Los Angeles, CA

		Emissions (tpy)		Unit Risk Factor	Unit Risk Factor	Cancer Risk Index Value		Chronic Risk Index Value	
CAS	Chemical Name	Gasoline Tank	WWTP	Cancer	Chronic	Gasoline Tank	WWTP	Gasoline Tank	WWTP
540841	2,2,4-trimethylpentane	0.002	-						
71432	Benzene	0.001	0.000	2.90E-05	6.00E+01	1.71E-08	1.37E-09	3.54E-02	2.84E-03
	Bis(2-ethylhexyl) Phthalate	-	0.000				0.00E+00		0.00E+00
	Bromomethane	-	0.000				0.00E+00		0.00E+00
67663	Chloroform	-	0.000	5.30E-06	3.00E+02		3.08E-10		1.74E-02
110827	Cyclohexane	0.002	-			0.00E+00		0.00E+00	
100414	Ethylbenzene	0.000	0.000		2.00E+03	0.00E+00	0.00E+00	3.87E-01	5.64E-01
78784	isopentane	0.061	-			0.00E+00		0.00E+00	
98828	Isopropylbenzene (cumene)	0.000	-			0.00E+00		0.00E+00	
108383	m-xylene	0.001	-		7.00E+02	0.00E+00		3.93E-01	
110543	n-hexane	0.003	-		7.00E+03	0.00E+00		1.77E+01	
95476	o-xylene	0.000	-		7.00E+02	0.00E+00		1.47E-01	
106423	p-xylene	0.000	-		7.00E+02	0.00E+00		1.23E-01	
108883	Toluene	0.003	0.000		3.00E+02	0.00E+00	0.00E+00	8.37E-01	9.71E-02
1330207	Xylene (total)	0.001	0.001		7.00E+02	0.00E+00	0.00E+00	6.63E-01	4.07E-01
Total		**0.072**	**0.001**			**1.71E-08**	**1.68E-09**	**2.03E+01**	**1.09E+00**

APPENDIX J

SOURCE TREATMENT AND ASSUMPTIONS FOR AIR DISPERSION MODELING FOR NON-LOCOMOTIVE SOURCES

Appendix J

Source Treatment and Assumptions for Air Dispersion Modeling for Non-Locomotive Sources

As shown in Figure 3 emissions were allocated spatially throughout the Yard in the areas where each source type operates or is most likely to operate. Emissions from mobile sources, low-level cargo handling equipment, heavy equipment, and moving locomotives were simulated as a series of volume sources along their corresponding travel routes and work areas. Yard hostlers, heavy duty trucks, and other low-level emission sources are first allocated to the areas of the yard where their activity occurs, and are then allocated uniformly to a series of sources within the defined areas. Depending on their magnitude and proximity to yard boundaries, idling emissions for heavy duty trucks may be treated as point sources rather than being included in the non-idling volume sources used to characterize moving vehicles. Idling of locomotives and elevated cargo handling equipment (cranes) were simulated as a series of point sources within the areas where these events occur. Large sources such as RTGs and cranes that are stationary or slow moving are treated as point sources with appropriate stack parameters

Emissions from stationary sources, such as fuel tanks, were simulated as a point source corresponding to the actual equipment location with in the Yard. Assumptions used spatially to allocate emissions for each source group are shown in the Table below. See Figure 3 for the source locations. See Appendix A-4 for assumptions regarding the spatial allocation of locomotive emissions.

Source Treatment and Assumptions for Air Dispersion Modeling for Non-Locomotive Sources Commerce Rail Yard		
Source	Source Treatment	Assumptions for Spatial Allocation of Emissions
Gasoline Storage Tank	Point	Assumed all emissions occurred at the storage tank location.
HHD Diesel-Fueled Trucks – Intermodal Trucks (idling)	Volume	Assumed 1/3 of the total HHD truck idling occurred at the intermodal gate and the remainder occurred in the trailer parking area.
HHD Diesel-Fueled Trucks –(traveling)	Volume	Assumed that 90% of the emissions from HHD truck traveling occurred in the trailer parking area and the remaining 10% occurred on a route from the center of the unloading area to the gate.
Cargo Handling Equipment (low level)	Volume	<u>Chassis Stackers (2) and Lull Forklift</u> – assumed emissions were evenly allocated between the 2 chassis storage areas. <u>Yard Hostlers</u> – assumed 10% of the emissions occurred in and around the Tractor Maintenance Shop and remaining 90% of the emissions occurred in the trailer parking area. <u>Top Pick</u> - allocated all emissions the areas around the unloading tracks.
Cargo Handling Equipment (RTGs)	Point	Assumed 10% of the total emissions from RTGs occurred at the crane pad and the remaining emission occurred in the areas around the unloading tracks.
Heavy Equipment (idling and traveling)	Volume	Emissions from all heavy equipment were assumed to occur in and around the locomotive shop and service track.

APPENDIX K

SEASONAL AND DIURNAL ACTIVITY PROFILES

Appendix K

Development of Temporal Activity Profiles for the UPRR Commerce Yard

Locomotive activity can vary by time of day and season. For each yard, the number of trains arriving and departing from the yard in each month and each hour of the day was tabulated and used to develop temporal activity profiles for modeling. The number of locomotives released from service facilities in each month was also tabulated. The AERMOD EMISFACT SEASHR option was used to adjust emission rates by season and hour of the day, and the EMISFACT SEASON option was used where only seasonal adjustments were applied. Where hour of day adjustments (but not seasonal) were applied, the EMISFACT HROFDY option was used.

Time of day profiles for train idling activity were developed assuming that departure events involved locomotive idling during the hour of departure and the two preceding hours, and that arrival events involved locomotive idling during the hour of arrival and the two hours following. Thus, the hourly activity adjustment factor for hour *i* is given by

$$\frac{\frac{1}{3} \cdot \sum_{j=i}^{i+2} NA(j) + \frac{1}{3} \cdot \sum_{j=i-2}^{i} ND(j)}{\sum_{j=1}^{24} (NA(j) + ND(j))} \quad ,$$

where *NA(j)* and *ND(j)* are respectively the number of arriving and departing trains in hour *j*. These factors were applied to both idling on arriving and departing trains and idling in the service area (if applicable).

Similarly, time of day profiles for road power movements in the yard (arrivals, departures, and power moves) were developed without including arrivals in preceding hours and departures in subsequent hours. In this case, the hourly activity adjustment factor for hour *i* is given by

$$\frac{NA(i) + ND(i)}{\sum_{j=1}^{24} (NA(j) + ND(j))} \quad .$$

Seasonal adjustment factors are calculated as the sum of trains arriving and departing in each three month season, divided by the total number of arrivals and departures for the year. The hourly adjustment factors for each season are simply the product of the seasonal adjustment factor and the 24 hourly adjustment factors.

For yards with heavy duty truck and cargo handling activities related to rail traffic, seasonal train activity adjustments were applied, but not hour of day adjustments. Temporal profiles for yard switching operations were based on hourly (but not seasonal) factors developed from the operating shifts for the individual yard switching jobs. In some cases, locomotive load testing diurnal profiles were developed based on the specific times of day when load testing is conducted.

Table K-1 lists the hourly activity factors derived for train movements, train idling, and yard operations at the UPRR Commerce Yard. Separate temporal profiles are listed for day and night moving emissions as different volume source parameters are used for day and night. Table K-2 lists the seasonal activity factors for train activity and service activity.

Table K-1. Hourly Activity Factors for the UPRR Commerce Yard

Hour	Train and Service Idling	Train Movements (Daytime)	Train Movements (Nighttime)	Yard Switching Idling	Yard Switching (Daytime)	Yard Switching (Nighttime)	Load Testing East of Shop
1	1.028	0.000	1.163	0.0	0.0	0.0	0.0
2	0.894	0.000	1.041	0.0	0.0	0.0	0.0
3	0.810	0.000	0.882	0.0	0.0	0.0	0.0
4	0.851	0.000	0.760	0.0	0.0	0.0	0.0
5	0.966	0.000	0.789	0.0	0.0	0.0	0.0
6	0.925	0.000	1.003	0.0	0.0	0.0	0.0
7	0.819	1.105	0.000	0.0	0.0	0.0	0.0
8	0.819	0.668	0.000	1.5	1.5	0.0	3.0
9	0.788	0.684	0.000	1.5	1.5	0.0	3.0
10	0.832	1.105	0.000	1.5	1.5	0.0	3.0
11	0.891	0.575	0.000	1.5	1.5	0.0	3.0
12	1.182	0.814	0.000	1.5	1.5	0.0	3.0
13	1.258	1.284	0.000	1.5	1.5	0.0	3.0
14	1.091	1.447	0.000	1.5	1.5	0.0	3.0
15	0.863	1.044	0.000	1.5	1.5	0.0	3.0
16	0.816	0.783	0.000	1.5	1.5	0.0	0.0
17	1.155	0.763	0.000	1.5	1.5	0.0	0.0
18	1.117	0.901	0.000	1.5	1.5	0.0	0.0
19	1.136	0.000	1.801	1.5	0.0	1.5	0.0
20	0.995	0.000	0.648	1.5	0.0	1.5	0.0
21	1.113	0.000	0.958	1.5	0.0	1.5	0.0
22	1.261	0.000	1.380	1.5	0.0	1.5	0.0
23	1.188	0.000	1.000	1.5	0.0	1.5	0.0
24	1.202	0.000	1.402	0.0	0.0	0.0	0.0

Table K-2. Seasonal Activity Factors for the UPRR Commerce Yard

Activity Type	Winter	Spring	Summer	Fall
Trains	0.908	1.037	1.026	1.029
Service	0.887	1.019	1.062	1.032

APPENDIX L

SELECTION OF POPULATION FOR THE URBAN OPTION INPUT
IN AERMOD AIR DISPERSION MODELING ANALYSIS

Appendix L

Selection of Population for the Urban Option Input in AERMOD Air Dispersion Modeling Analysis

Urban heat islands and the thermal domes generated by them extend over an entire urbanized area[1]. Hot spots within the urban heat island are associated with roads and roofs, which surround each Union Pacific (UP) rail yard in high density. Following guidance cited by the ARB ("*For urban areas adjacent to or near other urban areas, or part of urban corridors, the user should attempt to identify that part of the urban area that will contribute to the urban heat island plume affecting the source.*"), it is the entire metropolitan area that contributes to the urban heat island plume affecting the rail yard. For metropolitan areas containing substantial amounts of open water, the area of water should not be included.

To simulate the effect of the urban heat island on turbulence in the boundary layer, especially at night, when the effect is substantial, AERMOD adjusts the height of the nighttime urban boundary layer for the heat flux emitted into the boundary layer by the urban surface, which is warmer than surrounding rural areas[2,3]. The difference between the urban and rural boundary layer temperatures is proportional to the maximum temperature difference of 12 Celsius degrees observed in a study of several Canadian cities, and directly related to the logarithm of the ratio of the urban population to a reference population of 2,000,000 (i.e., Montreal, the Canadian city with the maximum urban-rural temperature difference)[4].

The adjusted height of the nocturnal urban boundary layer is proportional to the one-fourth power of the ratio of the population of the city of interest to the reference population, based on the observation that the convective boundary layer depth is proportional to the square root of the city size, and city size is roughly proportional to the square root of its population, assuming constant population density[5]. Regardless of wind direction during any specific hour used by AERMOD, it is the entire metropolitan area, minus bodies of water, which moves additional heat flux into the atmosphere and affects its dispersive properties, not just the 400 km^2 area of the air dispersion modeling domain that surrounds the each rail yard, which was chosen purely for modeling convenience.

Continuing to follow the guidance cited by the ARB ("*If this approach results in the identification of clearly defined MSAs, then census data may be used as above to determine the appropriate population for input to AERMOD"),* the population of each Metropolitan Statistical Area is being used in the modeling run for each rail yard.

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[1] USEPA. *Thermally-Sensed Image of Houston*, http://www.epa.gov/heatisland/pilot/houston_thermal.htm, included in Heat Island Effect website, http://www.epa.gov/heatisland/about/index.html, accessed November 8, 2006.

[2] USEPA. *AERMOD: Description of Model Formulation,* Section 5.8 – Adjustments for the Urban Boundary Layer, pages 66-67, EPA-454/R-03-004, September 2004, accessed at http://www.epa.gov/scram001/7thconf/aermod/aermod_mfd.pdf on November 9,

[3] Oke, T.R. *City Size and the Urban Heat Island,* Atmospheric Environment, Volume 7, pp. 769-779, 1973.

[4] Ibid for References 3 and 4.

[5] Ibid.

APPENDIX M

DEMOGRAPHIC DATA

Appendix M

Population Shape Files for UPRR Rail Yards

The accompanying shape files include census boundaries as polygons and the corresponding residential populations from the 2000 U.S. Census. Separate shape files are included at the tract, block group, and block levels. The primary ID for each polygon begins with *ssccctttttt*, where *ss* is the FIPS state code (06 for California), *cc* is the county code, and *tttttt* is the tract code. The primary IDs for block groups have a single additional digit which is the block group number within each tract. Those for blocks have four additional digits identifying the block number. The population for each polygon are included as both the secondary ID and as attribute 1. Polygon coordinates are UTM zone 10 (Oakland and Stockton) or 11 (southern California yards), NAD83, in meters. The files contain entire tracts, block groups, or blocks that are completely contained within a specified area. For all yards except Stockton, the area included extends 10 kilometers beyond the 20 x 20 kilometer modeling domains. For Stockton, this area was extended to 20 kilometers beyond the modeling domain boundaries to avoid excluding some very large blocks.

In merging the population data[1] with the corresponding boundaries[2], it was noted that at all locations, there are defined census areas (primarily blocks, but in some cases block groups and tracts) for which there are no population records listed in the population files. Overlaying these boundaries on georeferenced aerial photos indicates that these are areas that likely have no residential populations (e.g., industrial areas and parks). The defined areas without population data have been excluded from these files. Areas with an identified population of zero have been included. It was also observed that some blocks, block groups and tracts with residential populations cover both residential areas and significant portions of the rail yards themselves. For this reason, any analysis of population exposures based on dispersion modeling should exclude receptors that are within the yard boundaries or within 20 meters of any modeled emission source locations.

To facilitate the exclusion of non-representative receptors, separate shape files have been generated that define the area within 20 meters of the yard boundaries for each yard. These files are also included with the accompanying population files. It should also be noted that the spatial extent of individual polygons can vary widely, even within the same type. For example, single blocks may be as small as 20 meters or as large as 10,000 meters or more in length. To estimate populations contained within specific areas, it may prove most useful to generate populations on a regular grid (e.g., 250 x 250 m cells) rather than attempting to process irregularly shaped polygons.

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[1] Population data were extracted from the *Census 2000 Summary File 1* DVD, issued by the U.S. Department of Commerce, September 2001.
[2] Boundaries were extracted from ESRI shapefiles (*.shp) created from the U.S. Census TIGER Line Files downloaded from ESRI (*http://arcdata.esri.com/data/tiger2000/tiger_download.cfm*).